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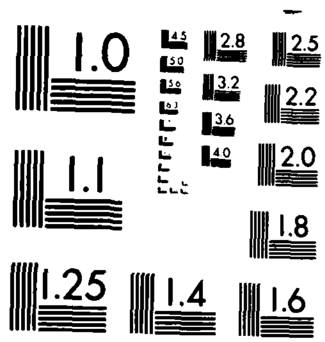

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GROUP TECHNOLOGY

ASSESSMENT

U.S. ARMY MATERIEL COMMAND

FINAL TECHNICAL REPORT
JANUARY, 1985

PREPARED UNDER CONTRACT NUMBER
DAAA09-83-C-4915 FOR THE U.S. ARMY
INDUSTRIAL BASE ENGINEERING ACTIVITY
ROCK ISLAND, ILLINOIS

CASE AND COMPANY, INC.
PRUDENTIAL PLAZA
CHICAGO, ILLINOIS

This project was funded by the US Army Industrial Base Engineering Activity based on the mission for that Activity outlined in Army Materiel Regulation 10-13. The Contracting Officer's Technical Representative for this contract was Mr. James H. Sullivan, US Army Industrial Base Engineering Activity, ATTN: AMXIB-MT, Rock Island, IL 61299-7260.

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The results of this report were presented at the Army Materiel Command Manufacturing Technology Policy Meeting, February 5, 1985, in Washington D.C. Briefing material is available from the controlling office (Block 11).

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Group Technology	Classification and Coding Systems	CAD/CAM
Process Planning	Standardization	
Cellular Manufacturing	Family-of-parts	
Procurement	Design Data Base	
Manufacturing Costs/Benefits	Plant Layout	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Because some independent efforts toward the use of Group Technology (GT) within AMC have been made in the past, and more are expected in the future, it was deemed timely to assess these efforts; determine current overall interest, potential, and issues; and begin to outline a strategy for the future use of GT at U.S. Army manufacturing facilities, government owned-government operated (GO-GO) and government owned-contractor operated (GO-CO).

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

The findings of this project revealed that since GT efforts began in 1979, little meaningful progress has been made. This is generally attributed to a lack of top management support, a scarcity of GT experience and knowledge within the various AMC organizations, difficulties encountered in the justification of funding, and certain organizational constraints. In the few instances where successful applications have been made, it was evident that a clear purpose, strong leadership, and a good understanding of GT concepts are essential.

From this assessment, it has been concluded that a significant potential for cost savings exists in the application of GT in the functions of manufacturing, design, and procurement at certain Army plants, arsenals, and depots. To obtain this potential will require an improved management awareness, the development of a more complete GT strategy, the commitment of resources, the initiation of key projects, and the maintenance of continuity.

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LIST OF EXHIBITS

I. INTRODUCTION

This chapter of the report provides a section which introduces the subject of Group Technology and describes some key principles of this operating philosophy. Also included are sections which relate the objectives and scope of this project, the technical approach employed to accomplish the objectives, and the planned project work schedule.

A. GROUP TECHNOLOGY DEFINED

Group Technology (GT) can be simply defined as the realization that many problems are similar, and that by grouping similar problems in a systematic manner, a single solution can be found to a set of problems, thus, saving time and effort. Therefore, GT identifies and exploits the underlying sameness of members of a universe to provide economies of scale. This general definition implies an extremely broad potential scope of application for GT principles. However, the most common applications are found in the design and manufacture of discrete products.

In actual practice, Group Technology focuses on the family of parts concept. That is, component parts are grouped into categories called "families." These families are formed based on similarities in the characteristics of the various parts. The end products, in which these parts are eventually used, are not relevant to the exploitation of these commonalities.

Although other applications exist, there are four major functional areas to which the family of parts concept is typically applied. These are:

1. Parts Design
2. Process Planning
3. Plant Layout
4. Purchasing.

The output of these functions is improved through GT, either independently or in concert. That is, these areas can be pursued individually or as major elements of a broad improvement strategy. The concepts employed in each of these four areas are explained in the paragraphs which follow.

Parts Design

Before a new part is designed, some of its major characteristics can usually be determined. If families of parts have been previously identified, a search based on the required characteristics of the new part may reveal that an existing part "as is,"

or with slight modifications, will serve the purpose. If a current part will serve the purpose, not only the cost of the new design is omitted but the much greater costs, of introducing another new part into all of the elements and functions of the organization, are also avoided. Consequently, the overall costs, associated with part proliferation, are reduced and the scale of the existing parts is increased. A major manufacturer of mailing equipment reported, several years ago, savings in excess of $250,000 per year from their GT program for part avoidance.

Even if a new part design is definitely required, by examining existing families of similar parts, the actual design effort can be greatly simplified. Further, the design of the resulting new part can incorporate, where possible, standardized features or preferred dimensions. These can be more easily identified if a GT data base exists.

In addition to the avoidance of new designs, the quantity of existing designs can often be reduced. By categorizing current parts into families displaying similar characteristics, duplication is often identified. Also, it is not unusual to find that several similar parts can be slightly modified to enable the use of a single part.

Group Technology in parts design recognizes the fact that while new parts requirements are constantly being introduced into the factory, the different characteristics required of these parts do not increase at the same rate. The characteristics required tend to reach a finite level. Retrievable past designs, modifications and efforts toward standardization can aid significantly in reducing the variables, avoiding entirely new designs and simplifying the manufacturing processes.

Process Planning

Most manufacturing in the world today involves the production of parts in small lot sizes. Only a relatively minor portion of manufacturing output is mass produced. These small lots are manufactured in what is termed batch, or job shop, environments.

As with parts design, job shop manufacturing tends to foster a proliferation of process plans. In most such production environments, similar parts are produced using a number of different production processes. This is the result of a variety of causes such as changes in volume or lot sizes over time, the procurement of new equipment, the creativity of the individual process planner or, simply, personnel turnover within the process planning department.

Whatever the cause, when existing part routings are critically examined, substantial improvement in the form of standardized process plans can usually result. A large supplier of oil field equipment found that 64 different expander sleeves were produced

42 different ways. An analysis revealed that they could be made using two basic process plans requiring four machines rather than the twenty which were currently used.

With standardized processes for existing part families, new components exhibiting similar manufacturing requirements can be processed as are other members of the appropriate family. Common tooling can also be used in these processes.

At this point, it is important to recognize that part families can be defined in different ways. Part families formed from a product design standpoint are not necessarily part families in the manufacturing sense. In design, part families may be formed based on such characteristics as shape, material and function. In manufacturing, similarities are related to the process and the equipment used to produce the part family. The members of a manufacturing part family are not necessarily similar in appearance but they undergo similar manufacturing processes. Conversely, design part families may appear similar but could require entirely different manufacturing processes.

Plant Layout

In a typical job shop, about 95% of the time, a part is either being transported or simply waiting for work to be done on it. Only 5% of the time is any value being added. This is true because of the processes employed, the number of different components vying for equipment, the methods of production scheduling and the nature of the plant layout.

Most batch manufacturing facilities are laid out according to function. That is, the plant layout depicts departments or work centers in which similar pieces of equipment are grouped. There exist drilling departments, or milling machine work centers, for example. This type of arrangement provides job shop manufacturers with a great deal of flexibility to meet customer needs. This also allows for the specialization of supervisors and operators.

The functional layout, however, is the cause of a large amount of hidden and indirect inefficiencies. Long travel distances and backtracking between departments result in a great deal of material movement. Parts waiting in queues, between individual operations, cause large work-in-process inventory investments and long lead times. In addition, the ability of the work center to process a wide variety of jobs results in a large amount of time devoted to changing the equipment setups. None of these deficiencies are corrected with improved manufacturing processes that simply increase machine speeds or otherwise reduce direct operating costs.

One application of Group Technology employs the use of a cellular manufacturing arrangement rather than a functional layout. The

cellular concept requires the physical arrangement of dissimilar machines into specific and limited geographic locations. If manufacturing families of parts are planned to be produced using a similar process, it follows that the equipment required for this process can be organized into a group of physically adjacent tools which form a "cell." In such an arrangement, the parts travel from machine to machine rather than from department to department. With GT cellular manufacturing, the traditional functional departments tend to disappear and be replaced by cells, each with a balanced complement of tools for producing parts requiring similar processes.

Thus, the cellular concept of Group Technology enables a "factory within a factory" approach. This typically results in a part being started and completed in a limited area of the facility with reduced travel, less queueing, shorter lead times and fewer setups. A leading farm equipment manufacturer has, for the past several years, been involved with major rearrangements of millions of square feet of manufacturing space to achieve cellular manufacturing.

Purchasing

The formation of part families, both from a design or functional viewpoint, and from a manufacturing or processing viewpoint, aids in improving the effectiveness of the purchasing function. By having the ability to bring together parts displaying similar characteristics, the procurement personnel can be well armed for achieving cost improvement.

First, the reduction in parts proliferation should reduce the number of individual items required and thereby add volume to those remaining. Quantity discounts can often result. Second, the move toward standardization typically results in lower prices. Standard parts are simply less expensive than specials. Finally, the grouping of similar materials helps to identify the low cost suppliers. Parts that are too expensive will stand out. These can be negotiated and/or shifted to another vendor. A large aerospace division discovered a virtually identical nut and coupling unit designed five times by five different engineers and supplied by five different vendors. The prices ranged from $.22 to $7.50 each.

Summary

Group Technology is a logical approach to attacking indirect inefficiencies. By focusing on the causes of these inefficiencies, GT can provide substantial benefits. Group Technology strives to achieve simplification and eliminate waste. It can bring the economies of scale normally associated with mass production to the job shop environment.

On the surface, Group Technology may seem to offer nothing new. The principles, if not the terminology, have been applied informally in many manufacturing environments. Process engineers have devised common routings for similar parts. Production personnel have combined part runs to take advantage of common setups. Product engineers have standardized on certain components. Industrial engineers have grouped dissimilar equipment to form flow lines with which to produce similar parts.

However, unlike these earlier disjointed efforts, Group Technology offers a systematic approach that enables an organization to capitalize more fully on non-apparent but still highly fruitful parts similarities.

Group Technology is a proven management strategy. It is compatible with, and supportive of, MRP, OPT, NC, CAD/CAM, FMS and all other modern manufacturing concepts. It has been used in Europe, Japan and the U.S. for a number of years with dramatic results. Although most applications have been in metal working and particularly machining operations, GT has been successfully used in fabrication, electronics, plastics and many other industrial environments. GT can be applied broadly to nearly an entire organization or implemented in certain unique segments of the business. The environment, and the potential benefits, cost justify the optimum degree of use.

B. OBJECTIVES AND SCOPE

The U.S. Army Materiel Command (AMC), headquartered in Alexandria, Virginia, is composed of a nationwide network of 65 installations and 101 sub-installations and separate units. Headquarters furnishes overall policy guidance. Major subcommands serve as middle management, and individual installations execute the materiel program.

In their continuing search for cost improvement, several facilities within the AMC organization have made investments in Group Technology related projects. More investments of this type are expected in the future at a number of AMC operations. Currently, these GT investment decisions are made by the individual AMC facilities. It was deemed appropriate, therefore, at this time to assess the desirability and feasibility of an overall AMC GT strategy.

Where applicable, GT can provide ample benefits. However, not all environments have the characteristics which allow GT to be implemented, or the potential savings to economically justify the required investment. An overall strategy could provide guidelines regarding the potential application of GT, as well as the related issues concerning investments and benefits.

Further, a common approach would be synergistic. The individual locations will not have to experience independent "trial and error" attempts or false starts. Rather, each can capitalize on the accumulated experience of all of the other locations. This would tend to accelerate the implementation of GT where it is feasible and help to avoid frustrations at installations where GT is not appropriate.

Thus, the overall goal of the project was to provide an objective assessment of AMC's current status and future strategy concerning the implementation of GT. The several specific objectives could be summarized as follows:

- To define the range of current GT applications, as well as potential applications, within AMC manufacturing facilities.
- To assess the current level of awareness and understanding of GT within the AMC organization.
- To provide an analysis of progress and future plans with respect to the continued implementation of GT.
- To develop recommendations which will enable AMC to accelerate the implementation of GT.
- To assist in the development of an overall strategy regarding GT at AMC which assures efficient and effective progress and overall economic justification.

After an initial mail survey of interest and experience in Group Technology among the various AMC organizations, approximately fifteen sites were to be selected for visits. This was to provide more in-depth information about GT involvement as well as GT opportunities, issues and ramifications.

C. TECHNICAL APPROACH

The overall project was divided into five distinct phases. Each phase required the accomplishment of specific tasks including the preparation of identified deliverables. The phases of the project were defined as follows:

- Phase I — Start-Up
- Phase II — Preliminary Data Collection and Analysis
- Phase III — Primary Data Collection and Analysis
- Phase IV — Follow-Up On-Site Surveys and Analysis
- Phase V — Completion.

The tasks and steps required for each of these phases are described below.

Phase I - Start-Up

The purpose of this initial phase was to gain a general understanding of the range of GT application and interest at AMC. It also provided an opportunity to review the planned activities and milestone schedule for the project, to resolve any technical and managerial issues, and to determine the requirements for preliminary data. This phase included two tasks:

Task 1 - Conduct Initial Project Meeting

Task 2 - Develop Preliminary Questionnaire.

After the initial meeting, a Preliminary Questionnaire (Interest Survey) was prepared. This concerned the collection of general information regarding each of the facilities that wished to participate in the assessment. The cover letter and the Interest Survey form are included in Appendix 1.

Phase II - Preliminary Data Collection and Analysis

The purpose of this phase was to identify those locations which would participate in the assessment; learn generally about current and planned GT activities; and gain insight into potential opportunities, underlying issues and apparent ramifications associated with GT. One task was included in this phase:

Task 3 - Analyze Preliminary Questionnaire and Develop Primary Questionnaire.

The Interest Survey was sent to a total of 47 AMC organizations and 26 responses were received. The responses were analyzed, an interim report was prepared and a Primary Questionnaire was developed. The Primary Questionnaire form and the cover letter are included as Appendix 2.

Phase III - Primary Data Collection and Analysis

The purpose of this phase was to acquire more comprehensive and specific data from GT users (as well as non-users with apparent GT potential), to analyze such data and to prepare an action plan for on-site visits. One task was included in this phase:

Task 4 - Analyze Primary Questionnaire and Develop Action Plan.

A total of 25 organizations were sent the Primary Questionnaire and nineteen were eventually returned. The responses were analyzed, an interim report was prepared and a list of potential locations for on-site visits was developed.

Phase IV - Follow-Up On-Site Surveys and Analysis

The purpose of this phase was to acquire in-depth information concerning AMC GT involvement; to develop an understanding of the opportunities, issues and ramifications; and to prepare a final report providing an assessment of current efforts and outlining and supporting specific recommendations to assist in the development of an overall AMC GT strategy. Two tasks were included in this phase:

Task 5 - Conduct On-Site Surveys

Task 6 - Prepare Final Report.

This report was prepared in draft form and submitted to AMC (U.S. Army Industrial Base Engineering Activity) for approval and comments. After receiving the government's comments, they were incorporated into the report and the final report was completed.

Phase V - Completion

The purpose of this phase of the project is to prepare and present an end-of-contract presentation. Prior to the presentation, a letter announcement and agenda relating to the presentation is to be prepared and distributed. Three tasks are included in this phase:

Task 7 - Prepare Presentation Plan and Announce Presentation

Task 8 - End-of-Contract Presentation

Task 9 - Deliver Copy of Presentation.

Administrative

In conjunction with the five preceding phases of the plan of accomplishment, two administrative tasks needed to be performed:

Task 10 - Prepare Performance and Cost Reports

Task 11 - Attend Project Meetings.

At the end of each of the Phases I through V, performance and cost reports were prepared and submitted. In addition, periodic meetings were held with the Contracting Officer's Technical Representative during the course of the project to discuss progress and status.

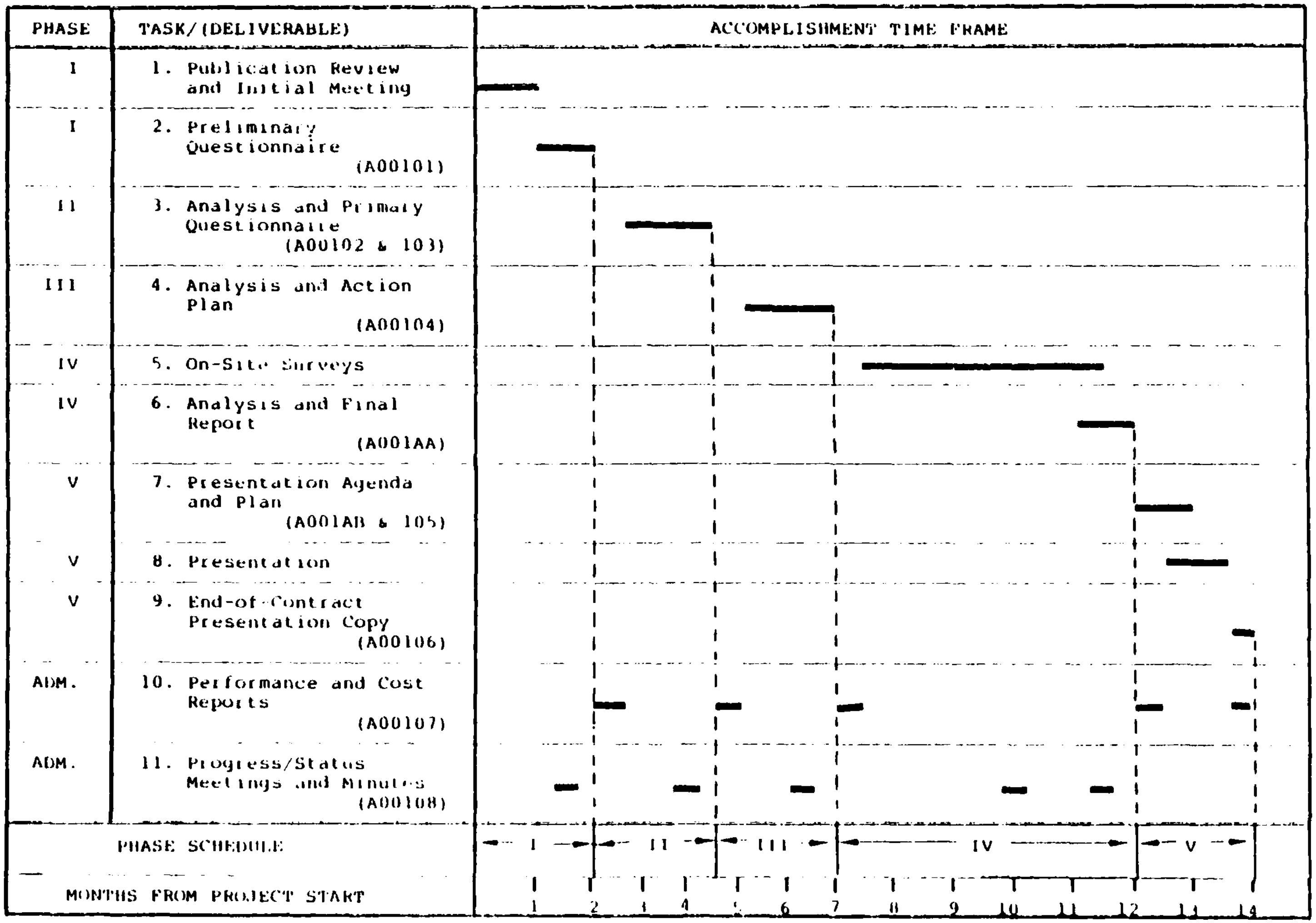
D. PROJECT WORK SCHEDULE

The planned work schedule for accomplishing the tasks and phases, and providing the project deliverables, described in the preceding pages, is shown as Exhibit I-1. The schedule was intended to be responsive to the timing requirements for the total project as defined in the RFP. A fourteen month time frame for completion was anticipated.

The project was begun on approximately November 1, 1983, with completion expected on December 31, 1984. The fourteen month time frame established for total completion of the project attempted to anticipate expected delays while awaiting approvals of such items as the questionnaires and action plans, and waiting for returns of the completed questionnaires from the various locations. No extended delays occurred while awaiting approvals. However, the delays experienced both in receiving responses to the questionnaires and in scheduling the on-site visits were much greater than had been anticipated. Therefore, the overall completion of the project is expected to be approximately two months longer than originally planned.

EXHIBIT I-1

PROJECT SCHEDULE



II. DISCUSSION

This chapter of the report presents the complete findings of the Group Technology Assessment Project. Subsequent chapters will contain the conclusions drawn from these findings and the recommendations arising from these efforts.

Sections of this chapter contain a description of the current level of GT interest and knowledge as well as separate headings for the various applications and plans for GT in such areas as cellular manufacturing, process planning, product design, procurement and others. Finally, the information collected relating to investments and benefits associated with GT is presented.

A. APPARENT GT INTEREST

In general, interest in Group Technology was found to be at a relatively low level. A few individuals scattered throughout the various organizations displayed a great deal of enthusiasm for GT and its potential applications to U.S. Army design, manufacturing and procurement activities. But for the most part, this reaction was the exception. The vast majority were either indifferent due to ignorance of GT concepts, or negative toward any change in the status quo.

Results of the First Mailing

Prior to the commencement of the project, it was anticipated that approximately 75 organizations within AMC would participate in this assessment. After a more complete review, this list was refined to 47 during Phase I.

The original project plan assumed that the purpose of the first mailing was to obtain preliminary information concerning current GT applications and plans, or the potential for the use of GT at the various installations. However, the purpose of the first mailing became a survey of interest to identify those locations which would participate further in the assessment. A general description of Group Technology was included with the mailing.

Of the 47 organizations contacted, 26 responded. Of the 26 which responded, only twelve definitely agreed to participate further in the assessment. Another seven indicated an uncertainty to continued participation. Exhibit II-1 relates the results of the Interest Survey question regarding continued participation, by the type of organization responding.

Another aspect of this first mailing, that concerns the subject of GT interest, was the timeliness of the responses. The mailing was made on January 5, 1984, with a request for return by February 10. By the requested date, only fifteen responses were received, with less than half agreeing to further participation. Another two weeks were spent encouraging others to submit their responses. The start of the analysis of the responses was delayed until February 28 instead of the planned date of February 14.

Results of the Second Mailing

Notwithstanding the fact that only twelve organizations had definitely agreed to continued participation after the first mailing, the Primary Questionnaire was mailed to 25 organizations. The initial list was expanded by a few late responders to the Interest Survey, by encouraging participation of some of those who were uncertain, and by personal persuasion at some key installations which did not even respond. At the time of the second mailing, seventeen had agreed and eight were still uncertain.

Responses to the Primary Questionnaire totaled seventeen. Only 76% of those who agreed to participate submitted their completed questionnaire. The response to the Primary Questionnaire by location is shown as Exhibit II-2. Subsequently, responses were received from AMCCOM-ARDC and from the Detroit Tank Plant, bringing the eventual total to nineteen. Watervliet Arsenal, although initially agreeing to further participation, later concluded that they could not provide a response to the Primary Questionnaire due to security reasons.

Again, the timeliness of the responses caused serious delays in the project. The Primary Questionnaire was mailed on April 27, 1984, and participants were asked to respond by May 25. By May 25, only six responses were received. It was not until July 1 that the seventeen responses were received and the analysis begun.

One other aspect concerning GT interest, related to this mailing, was the degree of completeness of the responses. Only five locations of the seventeen responding completed the questionnaire section relating to GT plans and experiences, and only eight responded to questions relating to GT knowledge.

On-Site Visits

At this stage, two points became obvious:

1. Unless on-site visits were begun before all of the Primary Questionnaires were returned, the project would undergo even more serious delays in completion.

2. Because very little information concerning Group Technology was being received through the responses to the questionnaires, the on-site visits were crucial to the value of the entire assessment project.

In early June, efforts were made to schedule the on-site visits. On June 12, visits were begun, starting at the Rock Island Arsenal. The visits were completed nearly five months later, on November 5, at the Iowa Army Ammunition Plant. The complete list of the fourteen organizations visited during this period is shown as Exhibit II-3.

Some difficulties were experienced in scheduling visits but they were all overcome. All sites that had been suggested for a visit eventually agreed and the dates were arranged. In two instances, the dates had to be changed due to subsequent conflicts at the site.

But more seriously, at two other sites, the individuals who had agreed to the visit and established the date were no longer working at the facility when the visit was made. Further, they had not told anyone else of the impending visit and the site personnel were not prepared. In both cases, no one at the site had much knowledge of GT or the assessment project. At best, the visit was useful only from the standpoint of obtaining a better understanding of the site operation and its possible use of Group Technology.

One measure of GT interest, revealed by the site visits, is the number of people made available for individual discussions at the time of the visit. Each location to be visited was sent an identical letter requesting that all key individuals who were, or could be, involved in a GT effort at the site be available for personal interview. The following table summarizes the number of people interviewed at each of the sites visited:

1 or 2	4 or 5	13 or 14
AMCCOM-ARDC	Red River AD	Corpus Christi AD
Benet Weapons Lab	Tooele AD	Stratford Engine Plant
Anniston AD	Rock Island Arsenal	
Sacramento AD		
Crane AAA		
Iowa AAP		
Mississippi AAP		
Detroit Tank Plant		
Lima Tank Plant		

In addition to the personal interviews, a tour of the facility was requested. This also ranged considerably, from brief visits to isolated sections to complete tours of all operations. Finally, all relevant documentation was requested for review. Some provided complete modernization plans, related articles and reports, organization charts and other data, while others gave

only the barest outlines of intentions or nothing at all. At one location, a draft report dealing with the expected future use of GT was denied to the visitor because it had not yet been approved by all parties. At another location, it was learned that a GT report was presented shortly after the visit, but no invitation for the presentation or copy of the report was offered or received.

Top Management Interest

If this assessment had been undertaken for a private, major, multi-plant U.S. manufacturing company, it would be expected that top corporate officials, division officers and plant managers would have taken an active interest in the project development, individual participation and information input to the project. The lack of such activities by AMC personnel is conspicuous by its absence. No top management personnel from AMC HQ, the sub-commands, or even the individual locations offered input to this project. This apparent lack of interest displayed by top management is a very significant finding.

Where interest in GT was located, it was generally at a fairly low level in the organization structures or in a staff role. There are isolated groups of individuals who are excited about GT and interested in starting or furthering a program. However, they do not have the authority to follow through with their interests and are frustrated with the lack of top management understanding and support.

Nine locations have been identified as displaying a considerable interest in GT. The table below lists these organizations with an assessment of the top management support displayed:

	Apparent Support	No Apparent Support	Undetermined Support
Tooele AD			X
Anniston AD	X		
Corpus Christi AD	X		
Detroit Tank Plant			X
Lima Tank Plant	X		
Stratford Engine Plant	X		
Rock Island Arsenal		X	
AMCCOM-ARDC		X	
Benet Weapons Lab		X	

Only at four locations was there a clear display of top management interest in Group Technology.

B. GT KNOWLEDGE

Closely related to the interest in GT is the knowledge of the subject and experience in its use. Without some background in this philosophy, it would be difficult for anyone to generate interest. It is evident that this background is lacking; few individuals demonstrated a working knowledge of the principles of Group Technology.

GT Definition Confusion

One error, common in industry and also revealed during this project, is to confuse classification and coding with Group Technology. Classification and coding systems exist primarily to provide a means of part characteristic identification. These systems enable the user to readily form part families, either in design or manufacturing, by retrieving all components with similar codes. However, coding parts does not provide a Group Technology approach anymore than buying software will provide a sound materials management strategy.

Group Technology is a concept, a philosophy, or a strategy; it is not a "canned" system. There are a number of tools, techniques and systems that can be useful when attempting to apply a GT approach. But the use of any of these does not constitute GT. More on the subject of classification and coding is presented in a later section of this chapter.

A somewhat related lament heard a few times during this assessment is that funding for GT is difficult to obtain. This implies that a large investment is necessary to apply Group Technology. This investment is typically associated with the expected purchase and use of a classification and coding system. The cost of the system and the labor intensive activity of coding parts can result in a large initial investment. Sometimes this investment is justified. However, there is usually no need to invest heavily in starting GT and certainly not before a total plan is prepared which defines the ultimate direction, details the various steps and provides the economic justification for the investment.

The following comments illustrate further the lack of GT knowledge present at the installations visited:

> "Our consultant answered all of the questions in the Primary Questionnaire. I really didn't understand most of it."
>
> Chief, Major Improvement Program

> "I feel there is a need for Group Technology but I haven't defined where."
>
> Chief, Engineering Division

"I don't know anything about GT or why you would be talking to me about it."

Supervisor, Industrial Engineering

"We always have had GT thinking informally and this will continue. The formal approach has not been proven and is hard to sell."

Chief, Management Office

"The 'ten year' engineer is a serious problem throughout AMC. He is seniority based, shys away from computers and resists any new concepts."

Program Manager

GT Knowledge Assessment

A section of the Primary Questionnaire was aimed at collecting information which would relate how well and how widespread knowledge of GT is present at the Army manufacturing facilities. Eight individuals completed and returned this section. Respondees were asked to check the description which best captures the degree of their familiarity with GT. The following summarizes these responses:

Have merely heard of the term	-	0
Have a vague understanding	-	0
Somewhat familiar with concepts	-	6
Have a working familiarity	-	1
Am very knowledgeable	-	1
Consider myself an expert	-	0

The respondees were also asked to indicate the sources that caused their familiarity with GT. The results of this inquiry are as follows:

Have heard presentations	-	7
Have attended GT conferences	-	2
Have read about GT	-	6
Heard about from colleagues	-	5
Visited GT installations	-	2

GT was used where I worked	-	1
Was directly involved in GT programs	-	2

The above tables indicate a very small number of people with GT knowledge, and a limited depth generally.

Based on the fourteen on-site visits, GT knowledge would be assessed as follows:

	Very Limited Or No Knowledge	Few Knowledgeable Individuals	Somewhat Dispersed Knowledge
Supervisory/Support	0	2	0
Ammunition Plants	3	0	0
Depots	2	1	2
Plants and Arsenals	1	0	3
	6	3	5

Given the level and amount of GT knowledge present in U.S. Army manufacturing facilities, the general lack of interest in GT is understandable.

C. ARMY GT EXPERIENCE

It was informally reported that the first known use of GT was an investigatory project conducted in the early 1970's. It was further explained that this project was classified and could not be discussed. However, a report published in 1983 refers to what was defined as a GT project at the Benet Weapons Lab in 1971 concerning the potential use of a classification scheme for examining machining processes.

MMT Program

Of those projects that could be discussed, it appears that formal efforts in GT began in 1979. At least three projects were started in that year under the Manufacturing Methods and Technology (MMT) Program:

- Application of Group Technology to Rock Island Arsenal Manufacturing
- Group Technology for Fire Control Parts and Assemblies - ARDC, Dover, New Jersey.
- Group Technology of Weapons Systems (funded by Benet for use at Watervliet Arsenal).

It appears that these projects were expected to cover a wide range of activities and investigations. At least the first two projects seemed to be still open at the time of the on-site visits. All three projects used the resources of Organization for Industrial Research (OIR) for their MiClass Parts Classification and Coding System and other activities. All three also shared in a contract with Pennsylvania State University dealing with a Group Technology Scheduling Software Program. Other aspects of these projects included cellular layout, computer-aided process planning, integrated design and manufacturing systems and a GT electronics classification and coding system.

IPI Program

The next major thrust related to GT seems to have come through the Industrial Productivity Improvement (IPI) Program. The Avco Lycoming Division Stratford Engine Plant claims to be responsible for the first Army effort under this program. Phase I began in September 1981. Phase II is presently nearing completion. This facility is well underway to creating their "Factory of the Future." Their goal is to have the most advanced turbine manufacturing facility in the world. They have assembled a team of very knowledgeable and talented personnel. Group Technology principles are widely incorporated into their plans. Of particular interest is their in-house development of OPSNET (Operations Sorting Network) software. This is a computer based system for establishing manufacturing part families without the use of a formal classification and coding system.

The Detroit and Lima Tank Plants, operated by General Dynamics Land Systems Division, are now also participating in the IPI Program. Phase I is nearing completion and they maintain that GT concepts will play an important role in their subsequent efforts. Three consulting firms (Arthur Andersen, Ingersoll Engineers and SHG) are assisting in this effort.

The Lima Plant, with an incentive for improving space utilization, developed a successful application of cellular manufacturing, even prior to the completion of the IPI Phase I effort.

Depot Modernization

The most recent impetus to the use of GT is the Depot Modernization Programs. Both Anniston and Tooele report that they are planning to use GT approaches in their improvement efforts. Corpus Christi, with a strong team of capable personnel on board, has also demonstrated a serious interest in Group Technology. However, no specific mention of GT could be found in their recently published Modernization Plan.

Summary of Use

The following table summarizes the current status of GT at locations visited for this assessment:

	No GT Plans Or Programs	Studying Or Planning GT	Limited Applications In Place
Support/Supervisory	0	2	0
Ammunition Plants	3	0	0
Depots	2	2	1
Plants/Arsenals	0	2	2
	5	6	3

Further discussions of the various GT efforts described in this section are related in subsequent sections of this chapter.

D. CLASSIFICATION AND CODING

As mentioned earlier, Rock Island, Watervliet and AMCCOM-ARDC at Dover have all been involved with the OIR MiClass Classification and Coding System. Personnel at each location were trained in the system. Parts were reported to be coded in the following approximate quantities:

Rock Island	-	3,000
Watervliet	-	2,500
Dover	-	3,500.

These coding efforts, which required up to a year to accomplish, have not yielded any apparent results. Rock Island admits that their REARM modernization program is proceeding along without any use of these coded parts. Watervliet describes their coding system as "dormant." Dover explains their coding efforts provided "experience." Many of those trained at all three locations have left or have been reassigned to other duties.

Of particular interest is that all three locations seemed to have proceeded with the same classification and coding system in different ways. They did not use the same rationale in the portion of the code to be tailored by the user such as for special shapes and special radii. The machine codes and the material codes were not standardized. Thus, there is no basis for data and/or part transfer between locations. It was reported that even the hardware and some of the software used is different in each of the three locations.

In contrast to these formal classification and coding efforts which have so far failed to demonstrate any particular benefits,

the Stratford Engine Plant personnel developed the OPSNET system. The objective of the system was to identify part families which could be manufactured using common processes in a cellular or production line mode. OPSNET development began in September 1982 and a preliminary design was completed in June, 1983. The total effort resulted in fifteen integrated software modules and the major output was the factory design data base. OPSNET made use of two recognized techniques, Production Flow Analysis and Decision Support Networks to avoid the costly use of a classification and coding system. Most importantly, OPSNET produced significant results in a timely manner.

It is not clear what the General Dynamics, Land System Division, is planning with regard to classification and coding at the Detroit and Lima Tank Plants. They reported informally that they will probably develop their own unique system with an OIR MiClass base, enhanced by Arthur Andersen. The enhancement presumably will include a "popularity code" which includes cost and usage in a traditional Pareto (ABC) approach. The aim of this enhancement is to encourage part standardization. Not enough information was made available to assess the merits of this approach.

E. CELLULAR MANUFACTURING

At least three organizations, Lima, Anniston and Stratford, have cells either in operation or firmly planned. Corpus Christi is investigating the feasibility of a panel repair cell and another in machining. Rock Island had planned for a pilot cell in 1979 and a total plant rearrangement with a cellular layout in 1980. These efforts have been largely abandoned as the modernization program management chose to go in a different direction. Watervliet had also planned to demonstrate a pilot cell in the early 1980's but this effort was abandoned due to internal resistance. Continued GT efforts resulted in the identification of six potential cells at Watervliet. One cell for seven shaft/spindle type parts containing five machines may become a pilot installation in 1985.

Detroit seems to be planning for three cells:

Aluminum Manufacturing
Tension Bar Housing
Road Wheel Hub.

However, no information on these planned cells could be provided.

Lima

The need for additional space to accommodate an increased assembly schedule required the Manufacturing Engineering Group to

analyze their alternatives for machining the 71 parts produced at Lima. They analyzed the processes for these 71 parts and developed a machine layout and process flow that provided the following benefits:

- Reduced machines from 44 to 21.
- Reduced floor space from 34,000 square feet to 18,000 square feet.
- Reduced fixture inventory from sixty fixtures to thirty fixtures.
- Reduced manpower requirements from eighty operators to fifty operators.
- Reduced supervisors from five to three.

The project was completed ahead of schedule and under budget. The project required:

- Six engineers part-time in addition to their normal responsibilities.
- One calendar year to complete.
- Three new machines.
- Relocation of eighteen old machines.
- Disposing of 26 old machines.
- Designing two multi-position fixtures and five univeral fixtures to reduce setup times.

The engineers used a Production Flow Analysis matrix showing machine operations by part number to analyze the processes. This analysis identified "families" of machining sequences. They then used these sequences to establish the machine department layout. A single machining cell consisting of five machines and a hand operation was established to completely machine one part. This cell is manned by one operator. The other machines are either dedicated to specific parts or are used for operations on a variety of parts. They are located to reduce material handling but are not positioned in cells.

Anniston

A small machine shop rebuilds approximately thirty items for the M-48 and M-60 tanks. The shop is congested with poor material flow and a conventional layout. The Modernization Planning Group decided to try GT concepts in modernizing the facility.

An analysis of the thirty items revealed that two items had potential for cellular manufacturing. These two items are the road-wheel arms and the final drive hubs. Processes for these two items were analyzed and one machine cell consisting of twelve machine tools was laid out to machine the parts.

The project was started in 1981 and is scheduled for construction in 1986 and operation in 1987. Therefore, no experience has yet been gained nor any benefits realized.

Stratford

The logic developed by the management team, and supported by the OPSNET software, concerning the future factory design is quite impressive. The total factory is divided into a number of major manufacturing centers. These centers in turn are subdivided into part family production lines or manufacturing cells. The distinction being that the lines are unidirectional in flow while the cells are not. Where practical, lines are chosen over cells to maintain a straight through flow.

Because cell or line size can be somewhat arbitrary when all considerations are investigated, Stratford management decided to limit cell size to a maximum of 25,000 standard hours per year. This has been determined to be the optimum work load of a single supervisor.

Although at first it appears that the formation of the cells was simply an assignment of parts by name (such as large, medium or small shafts), this is not really the case. The cell names exist only as a convenient reference. The parts in the cell undergo similar processes. For example, the gear line produces some shafts because the operations are similar. The cells were in fact formed by an analysis of the process and the required annual hours of operation.

Some layout adjustments have been made for processes where one machine can serve two cells rather than placing under-utilized machines in each cell. Similarly, for capital intensive operations such as heat treat and plating, the parts must leave the cell. Support functions such as scheduling, maintenance, and material handling are assigned on a cell basis.

F. OTHER GT PLANS

Despite all of the various activities and programs investigated, there are no other clear applications of Group Technology already in place. However, thoughts and plans in various stages of formulation reveal a wide variety of interesting GT possibilities for the future.

Process Planning

Several locations have expressed a serious interest in Computer-Aided Process Planning (CAPP). The family of parts concept of Group Technology provides the basis for pursuing this goal. As expressed by one individual, retirements each year reduce the number of people with solid manufacturing process planning experience. This logic and knowledge should be captured in the computer. Another individual felt that the results that could be demonstrated with CAPP would be the best method of introducing GT to a skeptical or resistant environment. In contrast, another individual felt that reprocessing requires a lot of effort and probably not worth it. This type of negative comment, without any supporting evidence, does much to stifle initiative.

Stratford is hoping to introduce to its improvement programs in the future a major thrust into generative process planning. The OPSNET approach accepted the current processes as givens. The next step is to improve the process employed in each of the lines and cells through a thorough analysis of component requirements. A CAD/CAM committee has been formed and they have investigated such concepts and techniques as intelligent geometry, RIM from NASA, GTSS from Vought, and Unigraphics from McAuto. An approach is being formulated but funding has not been determined.

Similarly, Detroit's IPI program apparently will deal with improved process planning. The preliminary description of their approach includes not only the automated development of manufacturing process plans but also quality inspection plans. These will include the standardization of the process plans and inspection procedures in a single document. Tooling, equipment and gages will also be included.

Design

A number of individuals discussed the current or future use of computer-aided design activities. However, plans for the use of GT in product design are virtually nonexistent. Perhaps, because the design function is not always performed at the manufacturing location or because it is fragmented, a cohesive approach is difficult to accomplish.

One individual expressed the desirability of a "unified system of design." He envisioned a data base for all of AMC, or even DoD, that could be tapped to retrieve previous design efforts. This ideal situation would foster standardization and greatly reduce the need for new component designs.

Stratford is incorporating its design improvement activities with the process planning efforts of the CAD/CAM Committee. A major effort to achieving benefits with a GT approach is scheduled for the 1985-86 period.

Detroit's IPI effort includes a proposed Design Management Project which "involves capturing key permanent characteristics of parts and assemblies in a single GT data base."

Procurement

Although several individuals could envision the benefits of using GT in the procurement function, virtually no plans are underway to make this happen. GT could be useful in providing "should cost" data for the procurement function. Ideally, it could also be seen that all similar parts (families) could be packaged for negotiations on a single location, on an AMC, or even a multi-service basis, so that scale and its resulting economies are achieved.

It is believed that Detroit's proposed IPI program will include a Material Family Analysis Project which, among other features, addresses procurement by family rather than by individual part for both productive and nonproductive material.

Additional Areas

Several other potential applications of GT principles were discussed during the visits. Minimal efforts are currently underway but these do represent possible sources of benefits and illustrate some aspects of present thinking at the AMC locations.

For example, at Corpus Christi, one manager believes that tool design represents a good potential area for GT application. A substantial group of people spend time designing new tools for parts required to be manufactured in the helicopter repair areas. There is no present system to retrieve past tool designs to see if these older tools can be used as is or with modifications. In addition, these new tools often require new NC tapes. It is possible that the tapes could be used for a family of similar parts.

Detroit's proposed IPI program seems to cover this possibility also. They have identified a Fixture, Gage, and Equipment Standardization Project which ties into their GT projects.

It appears that Detroit even proposes to use GT concepts in the area of forms control. This would classify documents by application, user, source, disposition, security, etc.

Reference was made earlier to the project sponsored by Rock Island, Dover, and Watervliet in the area of group scheduling. It should be noted that current production scheduling systems, in general, usually do not recognize the existence of a cellular environment. Thus, the economies associated with reduced setup time by the proper scheduling of part families cannot be achieved. A set of algorithms developed for the cells is required. On this

basis, the project is worthwhile. However, no cells are in operation at these locations and the results of the project are only theoretical.

G. INVESTMENTS AND BENEFITS

Very little information was available concerning the amount of money invested in Group Technology programs. Even less data was provided which concerned expected tangible benefits. Because few programs have started and none have been completed, it was impossible to examine actual results.

Rock Island Arsenal

It appears that $123,000 was authorized in 1979 and spent for the initial OIR training and part coding. In 1980 an additional $155,000 was authorized to continue the initial efforts, and by March 1984, $140,000 was spent. The expected breakdown of funds was as follows:

In-House Labor	$ 56,370
OIR	81,290
Penn State (portion)	17,340
	$155,000

In December 1983, OIR provided a report which projected potential annual savings of nearly $2.4 million at Rock Island. These savings would be fully realized in the fifth year. Interim years would yield lesser amounts. To achieve these benefits, Rock Island would need to utilize the concept of standard process plans with an automatic process planning system and to dedicate machine tools to families of parts. Physical relocation of the machines would not be required. However, four types of costs would need to be incurred:

- Hardware
- Software
- Training and Consulting
- In-House Manpower.

The in-house manpower was estimated at two people per year. No expected cost amounts were provided in the report for hardware, software, training, and consulting. The potential savings projection was based on estimates derived from the experiences of other companies using GT. Improved costs were to be expected in setup and operating labor, tooling and equipment, rework and scrap, process planning time, and inventory investment. It is not clear if this report was prepared under the $278,000 previously

authorized or if additional funds were necessary. No tangible benefits were projected in the report from Pennsylvania State University submitted in September 1983.

ARDC-Dover

Between January 1979 and May 1983, $536,500 was authorized for funding of the GT efforts at Dover. The planned distribution of this amount was:

In-House Labor	$440,100
OIR	74,600
Penn State (portion)	21,800
	$536,500

As of July 1983, $473,300 had been expended.

In 1978, it was estimated that $380,000 would be required over a three year period to achieve annual savings of $1.2 million. This savings was based on a 20% reduction of the annual man-hours required in the manufacturing areas of tooling, machining, and optics/electronics processing and assembly. The 20% reduction was an estimate derived from a 30-40% manufacturing cost reduction generally reported by users of GT in Europe, Russia and the U.S.

Stratford

While not solely related to Group Technology, the principles of GT are playing an important role in the major improvement effort at the Stratford Engine Plant. It is expected that $90 million will be spent over a four year period to make the facility "the most cost efficient producer." The capacity of the one million square foot plant will be doubled and the following unquantified benefits are anticipated:

- Lower manufacturing time
- Better space utilization
- Reduced inventory
- Less material handling
- Improved quality.

There does not appear to be any doubt at the site that this investment will be cost justified.

EXHIBIT II-1

INTEREST SURVEY RESULTS

CONTINUED PARTICIPATION OF RESPONDENTS BY TYPE OF ORGANIZATION

Type	Respondent Total	Number "Yes"	Percent "Yes"	Number "Uncertain"	Percent "Uncertain"	Number "No"	Percent "No"
Major Subordinate Commands	6	3	50%	1	17%	2	33%
Ammunition Plants	7	3	42%	2	29%	2	29%
Depots	8	4	50%	2	25%	2	25%
Arsenals	1	1	100%	0	0%	0	0%
Laboratories	0	0	0%	0	0%	0	0%
Other Government Owned Plants	2	1	50%	0	0%	1	50%
Other Government Activities	2	0	0%	2	100%	0	0%
Totals	26	12		7		7	

EXHIBIT II-2

RESPONSE TO THE PRIMARY QUESTIONNAIRE
BY LOCATION

GROUP	ORGANIZATION	LOCATION	AGREED * TO PROCEED	RETURNED QUESTIONNAIRE
SUPERVISORY/SUPPORT ORGANIZATIONS	AMCCOM	Rock Island, IL	Y	
	AMCCOM-ARDC	Dover, NJ	Y	
	Production Base Modernization	Dover, NJ	U	
	DESCOM	Chambersburg, PA	Y	
AMMUNITION PLANTS	Crane AAA	Crane, IN	Y	X
	Iowa AAP	Middletown, IA	Y	X
	Lake City AAP	Independence, MO	U	
	Lone Star AAP	Texarkana, TX	U	
	Longhorn AAP	Marshall, TX	Y	X
	McAlester AAP	McAlester, OK	Y	X
	Milan AAP	Milan, TN	U	
	Mississippi AAP	Picayune, MS	Y	X
	Riverbank AAP	Riverbank, CA	U	X
DEPOTS	Anniston Army Depot	Anniston, AL	U	X
	Corpus Christi Army Depot	Corpus Christi, TX	Y	X
	Letterkenny Army Depot	Chambersburg, PA	-	X
	New Cumberland Army Depot	New Cumberland, PA	U	X
	Red River Army Depot	Texarkana, TX	Y	X
	Sacramento Army Depot	Sacramento, CA	Y	X
	Savanna Depot Activity	Savanna, IL	Y	X
	Seneca Army Depot	Romulus, NY	Y	X
	Tooele Army Depot	Tooele, VT	U	X
OTHER PLANTS	Rock Island Arsenal	Rock Island, IL	Y	X
	Watervliet Arsenal	Watervliet, NY	Y	
	Stratford Engine Plant	Stratford, CT	Y	X
	Detroit Tank Plant	Warren, MI	Y	
		TOTALS	25	17

* Y = Yes
U = Uncertain
\- = Did not respond to Interest Survey and was not sent Questionnaire

EXHIBIT II-3

ORGANIZATIONS VISITED

Supervisory Support

AMCCOM-ARDC	Dover, New Jersey
Benet Weapons Lab	Watervliet, New York

Army Ammunition Plants

Crane AAA	Crane, Indiana
Iowa AAP	Middletown, Iowa
Mississippi AAP	Picayune, Mississippi

Army Depots

Anniston	Anniston, Alabama
Corpus Christi	Corpus Christi, Texas
Red River	Texarkana, Texas
Sacramento	Sacramento, California
Tooele	Tooele, Utah

Arsenal/Plants

Rock Island Arsenal	Rock Island, Illinois
Stratford Army Engine Plant	Stratford, Connecticut
Lima Army Tank Plant	Lima, Ohio
Detroit Army Tank Plant	Warren, Michigan

III. CONCLUSIONS

This chapter of the report presents the conclusions drawn from the findings contained in the previous chapter. Sections of this chapter are devoted to a critique of current efforts and plans, the apparent potential for the use of GT at U.S. Army manufacturing facilities, and the issues and ramifications concerning GT. A strategy for the future and specific recommendations are provided in the next chapter.

A. CURRENT EFFORTS/PLANS

The actual use of GT in U.S. Army facilities is very limited. It is even less than what it at first appears to be. There are a few isolated areas where some success has been achieved or where it can be expected. Other efforts are floundering with no benefits in sight.

Use of GT

The actual use of, consideration of, or plans for Group Technology are not what was expected based on the responses to the Primary Questionnaire. When the responses on the completed questionnaires were compared with the results of the on-site visits, a substantial difference was observed. The following summarizes these differences:

Response matches actual	4
Response exaggerates actual	8
Response understates actual	2
Total organizations visited	14

Exhibit III-1 outlines these differences by location. In general, the reported use of, or plans for, GT are somewhat exaggerated.

Successful Efforts

Those efforts in GT that can be termed successful are few. Certainly the effort at Stratford appears to be the one with the highest potential for success but it is not yet implemented. The Lima cellular approach is impressive, as is the planned cell for Anniston.

There are some factors that can be isolated which relate to those GT applications that are, or probably will be, successful. They include:

- A compelling need - Lima was concerned with floor space for future requirements. Stratford is determined to be the low cost producer.

- In-house talent - The lead for the effort as well as the key resources were in-house and not supplied by outsiders.

- No fascination with a canned technique - Classification and coding systems were not essential. Stratford developed their own analysis software. Lima and Anniston based their efforts on internal knowledge of the parts and processes.

- A sense of direction - Whether for one cell or a completely redesigned facility, the ultimate goal was known early in the effort and pursued throughout the project.

Similarly, where no success has been demonstrated, certain characteristics are evident. These unsuccessful efforts depend too heavily on external parties without strong leadership or any internal ownership of the program. Or, they begin by classifying and coding without a clear indication of how the information would eventually be used. Or, there is internal resistance and a lack of top management support.

It can be concluded for the most part that a large amount of the funds expended for GT by the U.S. Army have yet to yield a return.

B. APPARENT POTENTIAL

It can be further concluded that there exists a significant potential for the selected use of GT concepts in U.S. Army manufacturing facilities. This conclusion is based on observation and discussions at the sites; it is expanded upon in subsequent paragraphs. This use can be effective in the manufacturing, design, and procurement activities. The degree of potential use would be limited by the type of organization.

Manufacturing

For both government owned-government operated (GOGO) facilities, such as the Rock Island Arsenal and the Watervliet Arsenal, and government owned-contractor operated (GOCO) factories, such as the Stratford Engine Plant and the Detroit Tank Plant, opportunities exist for the use of GT in manufacturing. Both Stratford and Lima demonstrated the successful use of cells. Part family routings, standardization of process plans, and CAPP all can be effectively utilized. Tooling standardization and group NC tape applications can also be effectively pursued.

Depots which perform manufacturing and rework operations such as Anniston, Tooele, and Corpus Christi have opportunities to establish cells for more efficient performance and faster throughput. Standardized and retrievable tool designs and NC tapes, as suggested at Corpus Christi, also appear feasible.

There does not appear to be any significant potential for GT in manufacturing at the ammunition plants. Based on the observations made at these sites, the facilities typically produce limited product lines in relatively high volumes. Processes and operations are also tightly controlled by safety constraints. These manufacturing operations appear to be better suited to mass production techniques.

Product Design

There is merit to the suggestion that there be a unified design data base, at least within AMC. This would require a major endeavor to achieve but it could be quite a beneficial undertaking. It would minimize new design efforts and foster component standardization. Such a data base would also facilitate repair and remanufacturing efforts at the depots.

Any effort of this nature should not be restricted by type of end product. Such an approach would defeat the purpose since the benefits to be derived would come from standardizing components between end products. Natural divisions of this effort could be between government and contractor designs or between major categories of components such as mechanical and electrical. Initial efforts should focus only on first level components and not subassemblies.

While the use of a classification and coding system may not be required to apply GT concepts in some of the manufacturing areas, a system of this type would be essential in the design area. However, it would only be effective if a common approach was developed for all locations and functions. Independent systems would not be effective in attempting to achieve a unified design data base.

Procurement

This is a virtually untapped opportunity. No significant efforts were observed to allow for the purchase of part families rather than by individual component. Economies could be achieved if all similar parts were brought together at the AMC, or even initially at the facility, level.

Again, a program of this type would require the ability to retrieve similar needs from a common data base and should start at the individual component level between all end products. With the extent of annual purchases (in excess of $22 billion) made for

the U.S. Army throughout AMC, even a relatively small percentage of savings on a limited number of items could yield enormous returns.

However, the effort required to achieve these benefits should not be understated. A program of this nature would require substantial resources committed to accomplishing results over a relatively long term.

C. ISSUES AND RAMIFICATIONS

While it has been concluded that there exists a substantial potential for the use of GT principles within AMC which would result in significant financial benefits, it is just as strongly concluded that there exist formidable obstacles which can hamper, or even prevent, meaningful accomplishment. These barriers are the lack of GT awareness and understanding; the proposal and justification system; and issues relating to the internal organizational structure. Any one of these could be sufficient to block progress. Taken together, their preventive power may be overwhelming.

Assessment of Awareness

All efforts toward the effective use of Group Technology are doomed to failure without the understanding and support of top management. This is true not only at the local level, but also at the AMC and sub-command levels. Because GT represents a philosophy and not a system per se, it cannot simply be delegated for implementation. The use of GT affects policies, organization and tradition. Unless there is an understanding of the underlying issues on a macro level, lower level efforts are futile. Functional empires and product walls need to be penetrated. This penetration requires management support. Comments such as, "We use GT informally," represent a lack of knowledge and a contradiction in terms. GT cannot be used informally; it must be planned and used deliberately to be successful.

Prior investigations of attempts at implementing GT in U.S. industry have revealed that one essential element to success is leadership. For every successful installation, there could be found a crusader who directed the effort. He had the faith and fervor of a zealot. He believed in the merits of his cause. This belief was derived from a thorough understanding of GT principles and the knowledge of the potential effects on the environment. He secured the cooperation between locations and disciplines to assure success. And, he assembled and developed a strong team to carefully plan and implement the program.

With few exceptions, there has been no evidence of this type of management leadership concerning GT at AMC. Virtually all efforts have been a "bottoms up" approach. Lower level management

or staff personnel have investigated GT, been sold on its merits and made attempts at influencing higher management. The result of these efforts has been minimal. These instigators lack the power and authority to implement major programs.

It is quite apparent that no higher level personnel had any significant influence on most of the existing programs. The use of the MiClass Classification and Coding System and OIR is a case in point. This concerns a proven system, widely accepted by industry, and backed by a qualified and professional organization. In general, there is nothing to be critical of with regard to OIR and MiClass. However, the efforts of the Rock Island Arsenal, Dover ARDC and the Watervliet Arsenal seem to be totally uncoordinated. Each is pursuing what appears to be the same direction, independently. They are investigating similar issues but using independent hardware, software, codes and techniques. What are the objectives? What are the expected benefits? When will they occur? Similar questions abound for top management:

> Why were the original 2-3 year efforts at Rock Island and Dover extended to 5-6 years?
>
> What was expected from the Penn State Group Scheduling System when there were no cells to schedule?
>
> Why must Anniston wait until 1986 to implement a cell which has already been planned?

In addition to the lack of top management involvement, understanding and support of GT, it is apparent that there is also a lack of knowledge and experience in GT at the middle and lower levels of management. Only a few key individuals really possess the grasp of GT for a successful effort. Major progress in GT implementation will require a strengthening of resources. In-house talent will be needed so that they can investigate and innovate. These are the people who should lead the outsiders, not vice versa. Outside personnel should be used to support, assist and augment. Ownership of the efforts should reside in-house. Without substantial internal involvement, resistance is natural. Only a program that is conceived and planned by in-house personnel has a reasonable chance of success.

Economic Justification

The second obstacle to progress in GT at AMC is the proposal and economic justification procedure. Investigating and applying GT is not similar to purchasing a machine tool or a software system. There is no way to accurately predict the exact cost or expected benefits. It must be quickly added that this dilemma is not unique to AMC. U.S. industry in general is wrestling with this problem, not only for GT but for many manufacturing improvement thrusts.

The problem stems from the widespread use of traditional cost accounting methods. These methods are based on relatively accurate measured direct costs, with indirect costs applied on a very gross basis. They were developed in times when direct labor and direct material constituted the largest increments of cost. Overhead was treated in a much less precise manner. In modern times, however, overhead represents a major cost and direct labor is minimal. Years of effort have been spent in driving down the cost of direct labor with high speed equipment and improved methods. At the same time, the cost of overhead to support these improved methods was increasing. GT, and other modern manufacturing concepts, primarily attack these overhead cost elements. Materials handling, equipment setup, tooling, inventory investment, quality and similar costs are favorably affected by GT. Unfortunately, the detailed values of these costs are not provided by current cost accounting systems. Thus, hard data is difficult to obtain for current conditions and even more difficult to predict for conceptually revised conditions.

In addition, there are costs that have never really been investigated. These are usually called "intangibles" because values have not been placed on them, not because they are not real costs. For example, what is the value of a common data base for manufacturing and design? What is the value of shorter lead times? Or, more accurate cost estimates? Or, the use of a standard part rather than a new design?

There is no easy answer to this problem. Despite the progress with computers and manufacturing innovations such as MRP, Just-In-Time, CAD/CAM, FMS and others, industry is still faced with the question of justification. For some, the answer is simple: innovate or liquidate! The solution is not how much will it save, but where will we be without it vis-a-vis our competition. There is merit to this approach. It is essential to survival to stay abreast of the state-of-the-art. The danger is in wasting resources by pursuing the fad. Only complete knowledge can distinguish between the two paths.

One other consideration concerning economic justification needs to be recognized. This concerns the extent of investment. There are no predetermined guidelines concerning the amount of investment necessary to apply GT. Because it is not a canned program, the investment can be minimal or substantial. The extent of justified investment depends on the eventual goals that are anticipated. This is clearly illustrated by applications of GT revealed during this project. The Stratford Engine Plant is using many GT principles in its major program for a completely new factory design. The investment is estimated at $90 million. On the other hand, a successful application of GT is anticipated at Anniston with the procurement of one machine tool.

The entire effort must be envisioned before a major investment is committed. For this to occur, an initial investigation of potential should be made and an approach conceived. A detailed

development of this approach will provide plans and objectives that will result in at least a preliminary assessment of costs and benefits before commitment. With a plan, any amount can be justified; without a plan, no amount should be authorized. Those who complain about a lack of funding for GT are clearly missing the point.

The Structure

In a project of this nature, it was not possible to completely study the AMC organizational structure and its implications. There was enough evidence collected, however, to conclude that there are present inherent obstacles to progress in GT.

One area of concern is the routine transfer of military personnel. This was apparent on two levels. At the top level, concern was expressed for the fact that because GT is a long term endeavor, continuity can be lost. A new top manager is not aware of the history of a particular site and cannot be expected to view the pursuit of a venture which is not producing immediate results with the same enthusiasm as those who began and supported the effort. This, of course, would not be a problem if the understanding and support of GT was universal at AMC, but it is not.

On another level, in at least one instance, the key individual who is providing any momentum to a GT effort is facing a transfer in six months. Apparently, no one else at the site is supporting the effort or is even knowledgeable of GT. Plans have been developed to implement a cell and further analyses of GT in manufacturing have been performed. These efforts may be lost unless the successor arrives with an equal fervor to complete the mission. Given the level of GT experience within AMC, this is not likely. As related earlier, in two other instances the individual who knew of GT and agreed to the site visit was no longer there when the visit occurred.

Another area of concern may be the program management concept. The program manager for the various weapons, vehicles and other products has the responsibility for all areas of the program to assure its successful production. GT, by its nature, must cut across product lines in design, manufacturing and procurement. Unless those pursuing the benefits of GT are allowed to penetrate the product line barriers, and the program managers are supportive of the GT principles, the benefits cannot be obtained. Restrictions on scope become restrictions on potential benefits.

The third area of concern, in the organization, concerns the active or passive resistance of certain personnel toward GT. This resistance can come from line personnel who are responsible for production and do not want to disturb the status quo with some new concepts proposed by staff "whiz kids." It can also come from seasoned staff personnel (termed earlier as the "ten year engineers") who have not stayed abreast of the state-of-the-art and

are content to apply familiar but obsolete thinking in their efforts. Without the support of both of these types of individuals, it is difficult to envision any effective change taking place. The answer is involvement. They must become a meaningful part of any GT improvement effort if it is to succeed.

Most of the concerns expressed in the above paragraphs regarding structure are larger than just the successful application of GT. They obviously are part of a larger picture which may or may not be subject to change. They are presented, however, as representing very vital concerns if GT is to be successfully applied at the U.S. Army manufacturing facilities in the future.

D. OVERALL STATUS

This chapter focused on the conclusions reached from an analysis of the findings contained in the previous chapter. While not much of significance has yet been accomplished through the employment of GT concepts, there are a number of possibilities for improvement in the future.

Some of the actions currently being planned should bring exciting results. However, it appears that the major efforts being contemplated are principally for the plants run by private contractors (i.e., Avco Lycoming and General Dynamics). The facilities operated by the military do not yet appear to have planned and/or executed comparable programs. As the preceding sections have described, there are a number of reasons which may have caused this condition.

The next chapter, which contains the recommendations arising from these conclusions, is primarily focused on the AMC organizations which are headed by the military. It is with the hope that these organizations can match, or even exceed, private efforts that the recommendations are presented.

EXHIBIT III-1

GROUP TECHNOLOGY USE, CONSIDERATIONS OR PLANS

REPORTED VS. OBSERVED

Organization	Questionnaire Response	Actual Condition
Tooele AD	Limited application in design, manufacturing and purchasing	Limited application in manufacturing
Sacramento AD	Considering in manufacturing and design	No apparent activity
Anniston AD	Planned in manufacturing	Planned in manufacturing
Red River AD	Considering in manufacturing	No knowledge of GT
Corpus Christi AD	Considering GT in many areas	Considering GT in many areas
Mississippi AAP	Considering GT in manufacturing	No large potential in manufacturing
Crane AAA	Considering GT in manufacturing	No large potential in manufacturing
Iowa AAP	No activity	No activity
Detroit Tank Plant	Planned in manufacturing	Plans not firm
Stratford Engine Plant	Used in manufacturing and design	Used in manufacturing and design
Rock Island	Limited installation in manufacturing	Parts coded, minimal implementation
Lima Tank Plant	No activity reported	Installation complete
AMCCOM-ARDC	Used in manufacturing and design	Parts coded, little application
Benet-Watervliet	Some coding	Analysis for manufacturing prepared

IV. RECOMMENDATIONS

A number of important recommendations have been developed based on a thorough analysis of the findings and a review of the conclusions reached during this project. The main thrust of these recommendations can be summarized in terms of objectives, as follows:

- Improve Management Awareness
- Develop a GT Strategy
- Commit Resources for Accomplishment
- Initiate Key Projects
- Maintain Continuity.

Each of these major points recommended for future action are discussed in separate sections of this chapter. Finally, an overview of the expected benefits is provided.

A. IMPROVE MANAGEMENT AWARENESS

The achievement of this first objective is absolutely essential to all other actions that may be taken in the future with respect to Group Technology at AMC. Without the knowledge of basic GT concepts and principles, as well as potential applications, it will be impossible to gather the support required to proceed in a meaningful direction. Key decision makers, policy influencers and other top management personnel should gain an appreciation and perspective regarding GT so that they can independently evaluate its potential application at AMC functions and locations. The successful implementation of GT will require leadership, perseverance, and patience, along with a belief in the eventual attainment of the benefits. It will also require the knowledge to assess the suitability of GT at a particular environment, or under certain constraints.

Confusion and misconceptions, such as the following, must be overcome and clarified:

- Group Technology is not a classification and coding system.
- Group Technology is not a "hard" technology.
- Group Technology cannot be purchased and installed.
- Group Technology does not always require a major financial investment.
- Group Technology does not apply to all environments.
- Group Technology cannot be pursued informally.

On the other hand, those who have the authority and responsibility for major improvement at AMC should be aware of the following:

- Group Technology is a philosophy or approach and is not a specific tool.
- Group Technology requires a long-term commitment for success.
- Group Technology requires user involvement in planning, development and implementation.
- Group Technology has been successfully applied in U.S. industry as well as in Europe, Japan and the U.S.S.R.
- Group Technology has relevance to specific areas of Army operations.

Obviously, an awareness campaign, such as described here, will not be easy to accomplish. It cannot be done by a single report, presentation or seminar. The campaign itself will have to be led by someone of authority and influence who can envision the merits of GT. The nature and conduct of this project did not provide the opportunity to recommend a particular individual of such stature.

Elements of the campaign, when conducted, should include:

1. The identification of key individuals by function, location and status.

2. The determination of the degree of exposure to GT for each individual identified.

3. The development of techniques and materials to be used which would include such items as:

   a. This report
   b. Appreciation seminars
   c. Videotapes
   d. Workshops
   e. Industrial plant visits
   f. Army examples of application
   g. Reading materials.

With regard to specific industrial applications and other general GT information, Appendix 4 contains a selected list of good sources of published and unpublished material as well as some leading U.S. companies with GT applications.

For assistance in certain aspects of this effort, AMC might contact an association such as SME (Society of Manufacturing Engineers) in regard to seminars in GT. They have conducted a number of such seminars and are not biased to any particular technique or tool.

The initial focus of this objective should be directed toward top and middle management. Education and training of lower level management personnel should await the acceptance of GT by top management.

B. DEVELOP A GT STRATEGY

There needs to be a "top down" effort to complement the embryonic "bottoms up" efforts that have begun in GT at AMC. If an awareness and an enthusiasm are created at the top, an AMC Steering Committee should be formed to develop a GT strategy. The Steering Committee can establish policies regarding GT, provide direction and support, and monitor progress in the future. Certain elements need to be addressed within the developed GT strategy. These are discussed in the following paragraphs of this section.

Scope of Effort

This project has identified certain areas of potential application for GT. Suggested key projects to begin work in these areas are described later in this chapter. The Steering Committee should either concur with these directions or revise the scope based on its own investigation and knowledge. For example, if for any number of reasons, GT applications in procurement do not appear to be feasible, it should be dropped from further consideration. On the other hand, if the awareness campaign has identified certain areas of potential applications that have not been covered by this project, they obviously should be included in the expected scope.

Time Schedule

Priorities should be attached to the various elements of the program identified in the scope of effort. These priorities should be based not only on potential financial return but on a recognition of the natural sequence of events which must take place for meaningful progress. When the priorities are developed, an estimate of time should be made to enable the establishment of initial target dates for accomplishment. Recognition that GT is a long-term commitment should temper the desire for immediate results.

This timetable should be periodically reviewed as experience is gained and results achieved. It is unrealistic to assume that the initially planned dates will remain the same as the program progresses. New information and changing conditions will require that the plans and priorities be revised.

Organization

There are a number of organizational issues which must be addressed and resolved as policy matters. These are essential to progress because they concern the resources to be used as well as the general acceptance of the program at the various locations.

Questions such as the following need to be answered:

- Will there be one individual or staff who will direct and/or coordinate the overall effort on a full time basis for all of the locations? Or, should the effort be directed independently by each location and/or function?

- Should there be a specially trained task force of GT specialists who will be available for project assignment throughout AMC? Or, should each location or function be directed to develop its own resources for feasibility studies, detailed planning and implementation?

- What will be the role of outside experts and consultants? What other types of outside resources should be used and under what conditions?

- At what point are users brought into the program? How are they utilized and what contributions are expected of them?

At this stage, the actual numbers, or even the sources of personnel, are not the issue. Answers to the above are needed only on a strategic basis to provide guidance for the development of specific plans for the GT effort.

Economic Justification

A key policy issue involves the requirements and procedures for the justification of a specific GT project. As noted earlier, it is extremely difficult to relate accurate financial benefits prior to commencing activity associated with GT. However, the risk of a major commitment of funds to an unfruitful endeavor can be minimized.

All proposed GT activities should be preceded by a feasibility study requiring a limited amount of time and money. If the results are positive, the feasibility study should result in a proposed scope of further effort with an order of magnitude of potential savings and cost along with expected timing and resources for detailed development.

The detailed development phase typically would require more time than the feasibility study but again very little or no capital investment. The purpose of this phase is to provide more accurate cost, benefit and investment data along with specific plans and resources needed for implementation. Only at this stage can a reasoned judgment be made to proceed with implementation.

In effect, the feasibility studies, and even the detailed development projects, are funded with "seed" money. They will produce no return financially but will provide the information needed to judge the merits of a subsequent investment. Traditional ROI and discounted cash flow concepts are not applicable in evaluating the merits of these projects. The go-no go decision must be based on prior knowledge of the subject and apparent potential. It is important, however, to limit the time and resources expended on projects of this nature. They should not be too general but rather be aimed at the investigation of a specific potential application.

In summary, the purpose of the feasibility study is to determine whether or not the subject is worth pursuing into detailed development. Similarly, the purpose of the detailed development is to rationalize, scope and justify implementation. It is important to recognize that the proposed application can be significantly expanded, severely limited, or judged totally unworthy at the conclusion of either the feasibility study or the detailed development project.

C. COMMIT RESOURCES FOR ACCOMPLISHMENT

Assuming that an enthusiasm for the potential of Group Technology has been generated and an overall initial strategy has been developed, the key to any true resolve toward GT is the commitment of resources. In this regard, top management personnel will need to make a commitment which includes personnel, funding, and their own time.

Develop Talent

Currently, there are very few individuals within AMC who have a good working knowledge of GT. There appears to be a serious lack of even general knowledge of the subject. Obviously, if progress is to be made in obtaining benefits through the use of GT, a much broader base of knowledge needs to be developed.

This base should permeate all levels of the organization. In addition to a top management awareness, there needs to be a deeper knowledge of tools, techniques, and applications at the lower and the middle levels.

Some talent can be recruited; GT can become an area of special interest in personnel specifications for certain positions. However, the development of talent in the numbers needed for meaningful progress will require concerted efforts in the education and training of present personnel.

A formal program, including structured discussions, required readings, outside seminars and user visits, on a continuing basis, will be required to develop the team needed at AMC.

Provide Funding

Top management will need to budget and approve the spending of funds and finance feasibility studies, detailed developments and implementation programs in GT. In addition, funding will be required initially for personnel recruitment and training.

The extent of funding for GT should be considered in the development of the GT strategy. It will not be possible to predetermine even a reasonable estimate for the years ahead. However, the amount of funding for the immediate future should relate to other discretionary programs and provide some indication of the priority and importance that top management gives to GT.

Management Involvement

An essential ingredient in the GT program will be the degree of top management involvement. The greater the involvement, the greater the success. A very clear relationship exists.

If top management initiates, displays an active interest and/or clearly supports an effort in GT, the results of the effort will be timely and useful. If not always immediately fruitful, it will add to the store of GT knowledge and experience.

On the other hand, a lack of management involvement (due to the press of more urgent priorities) will be clearly observed down the line and the results of the efforts will usually be meaningless.

D. INITIATE KEY PROJECTS

It would be presumptuous to attempt to list certain key projects that AMC should immediately pursue. This assessment by its nature was strategic and, therefore, the feasibility of GT in any one particular area was not determined.

Further, even if certain potential areas of GT application appear to be sound, it should be recognized that unless they are endorsed by the users, any hope of benefit is lost.

Therefore, the most fruitful projects will be those which are user initiated and management supported, and not those which theoretically should provide substantial benefits.

With the above concepts as preamble, and recognizing that all should start with feasibility studies, and if warranted, go on to detailed development prior to implementation, the following are offered as a preliminary "menu" of potentially rewarding initial projects for AMC:

a. Establish Manufacturing Cells

Pilot cell operations could probably be developed on a limited basis at all plants, arsenals and depots. Of course, the objective should not be to develop a cell but rather to reduce costs through cellular operations. The initial cells should be relatively small in size and require very little or no capital investment. This investment, of course, would be cost justified prior to implementation.

b. Develop Design Data Base

At whatever level appears to be feasible, or on the basis of a feasibility study, an effort should be initiated to establish families of parts of a certain defined category. The objectives should be to reduce part proliferation, reduce future design efforts and promote component standardization. Goals of an initial study in this area would be to obtain some order of magnitude of the economics of such a direction as well as the practicality of its acceptance and implementation.

c. Others

Other projects might be concerned with:

- The standardization of process plans for CAPP at any one of serveral locations.
- The design of part family tooling, such as Corpus Christi.
- The use of part families in value analysis.
- The economics of dedicated equipment to part families without rearrangement, such as Rock Island.
- The effects of family of parts purchasing on specific component groups.

The parameters of any of the initial key projects selected must be clearly spelled out. The objectives, scope, work plan, resources, timing and expected benefits should be understood and agreed upon before commencement. The results should be communicated at each stage to all concerned at all levels.

E. MAINTAIN CONTINUITY

Programs often fail because, after the initial wave of top management communication and endorsement, further efforts are not made to follow up and support with the same degree of enthusiasm.

GT is a long-term commitment. It is necessary to develop an effective "PR" and communications program as part of the maintenance effort. Fresh news should be constantly supplied to continue the momentum.

An essential point to maintain continuity is user involvement. This includes, in some cases, simply providing information on what is being planned. Fear of the unknown even exceeds resistance to the known.

In addition, getting input from those involved creates a better program and "developing ownership" of a program facilitates implementation.

Other elements of a program to maintain continuity could include:

- The establishment of an AMC GT center to collect and distribute GT related experience and literature.
- A GT newsletter which publicizes GT projects and applications inside and outside of AMC.
- A GT Users Group within AMC which meets regularly to share experiences, capitalizes on the economics of scale, and avoids duplication of effort.
- Regular visibility of AMC top management personnel associated with GT projects by visits to witness efforts first-hand, awarding of recognition to individual contributors, and public acknowledgement of fruitful endeavors.
- Continuing educational courses in GT for introduction to newcomers, appreciation for management and refreshers for key personnel.

To achieve continuing progress, it will be necessary to strive for a balance of effort. At the beginning, top management must react to the lower level efforts in attempting to promote the use of GT. This reaction, however, cannot be too overpowering or the result will appear as a management imposed program and resistance will occur. On the other hand, just the proper amount of initial top management support will encourage an even greater level of effort at the lower levels. This, in turn, should generate the next higher degree of top management reaction. A continuing build-up at both levels of this nature represents the ideal mechanism for expanding and maintaining the program.

F. EXPECTED BENEFITS

In a project of this nature, it is not possible to quantify the potential benefits that could occur through the use of GT at the various U.S. Army organizations. However, they would be substantial and deserve further investigation and analysis.

Based on studies done in the past of various users of GT in the U.S., quantifiable benefits were expected to be:

- Reduced new part designs - 3% to 10%
- Increased engineering productivity - up to 50%
- Reduced NC programming - up to 83%
- Reduced setup time - 20% to 30%
- Reduced tooling expense - 25% to 40%
- Work-in-process reduction - 25% to 40%
- Lead time reduction - up to 80%.

Other expected benefits which were not possible to quantify were: reduced process planning time, reduced materials handling expense, and improved quality levels.

The above cannot be assumed to result at all locations. They do, however, provide some indication of the degree of potential with GT.

While Group Technology may not be appropriate for all environments, it can have broad application in batch manufacturing. There is no ideal profile for GT application, but those using it successfully exhibit the following characteristics:

- A wide variety of product mix.
- A large number of component parts.
- Volumes which do not justify dedicated equipment.

Pressures on delivery requirements and an internal concern with inventory investment and production costs usually provide the impetus for action.

A decision to move toward Group Technology represents a major clash with the status quo. Traditional functions are upset and new thinking must be introduced. The natural resistance to change will be strong because GT affects all areas and changes the organization, the procedures, and the physical layout. It can even be accused of attacking the creativity of the designer and the ingenuity of the process planner. Perhaps one of the strongest reasons that GT has not been more fully implemented is that it is not something that can be done partially and still be effective. It requires top management leadership and a team of believers.

Group Technology is not a rigid science, but more of a flexible art. It is important to understand its precepts, but it is equally important to make the compromises that may be necessary. It focuses on managing for improvement and not for tradition.

Because of its potentially broad application within AMC in general and within any one organization in particular, GT offers a good possibility of substantially improving productivity. Just as the assembly lines and transfer lines have made mass production efficient, GT offers economic benefits to the batch producer. Considering the current pressures from ever-increasing costs, the alert manager should investigate Group Technology and its application to his environment.

V. EXECUTIVE SUMMARY

This chapter contains an overview of the four preceding chapters. It is included as a means of providing an executive summary of the entire report. The format of this chapter is identical to the format presented in the body of the report. Therefore, an expansion of a particular subject of interest contained in this summary can be readily located in the report.

A. INTRODUCTION

This section provides an introduction to the subject of Group Technology and a description of the objectives, scope, approach and work schedule for the project.

Group Technology

Group Technology has been defined as the realization that many problems are similar and that by grouping similar problems in a systematic manner a single solution can be found to a set of problems, thus saving time and effort. The most common applications of Group Technology are found in the design and manufacture of discrete products.

In actual practice, Group Technology focuses on the family of parts concept. The four major functional areas to which this family of parts concept is typically applied are:

- Parts Design
- Process Planning
- Plant Layout
- Purchasing.

In parts design, by categorizing current parts into families displaying similar characteristics, new designs can be avoided, or least modifications of existing designs can serve the purpose for new products. This encourages parts standardization and reduces part proliferation.

In process planning, Group Technology is employed in the job shop environment to reduce the proliferation of different process plans for similar parts. With standardized processes for part families, new components which exhibit similar manufacturing requirements, can be processed as are former members of the appropriate family.

The functional plant layout which is commonly found in a job shop causes a great deal of inefficiency. These inefficiencies are usually indirect and hidden, and they are caused by such things as long travel distances between processes, backtracking between departments, the amount of time that parts wait in queue before processing, the large buildup of work-in-process inventory, and the consequent long lead times. GT advocates a cellular equipment arrangement rather than a functional layout. This requires the physical arrangement of dissimilar machines into specific and limited geographic locations where a family of parts can be processed.

The fourth major area for the use of Group Technology in discrete part manufacturing is in the area of procurement. By having the ability to bring together parts displaying similar characteristics, the purchasing personnel can be armed for cost improvement. Buyers are able to increase scale with vendors, and by grouping similar materials, high cost suppliers are identified.

In summary, Group Technology is a logical approach to attacking indirect inefficiencies. GT strives to achieve simplification and eliminate waste. It can bring the economies of scale normally associated with mass production to the job shop environment. Group Technology offers a systematic approach that enables an organization to capitalize more fully on non-apparent but highly fruitful part similarities. It is a proven management strategy, compatible with all current manufacturing concepts. It has been used in the U.S. as well as other parts of the world with dramatic results. It can be applied broadly, to nearly an entire organization, or implemented in certain unique segments of the business.

Objectives of the Project

Several organizations within AMC have made investments in Group Technology. More investments of this type are expected in the future. It was deemed appropriate, therefore, to assess the desirability and feasibility of an overall AMC GT strategy. Such a strategy could provide guidelines regarding the potential application of GT as well as the related issues concerning investment and benefits.

The specific objectives outlined for the project are:

- To define the range of current and potential applications of Group Technology within AMC.
- To assess the current level of awareness and understanding of GT.
- To provide an analysis of progress and future plans.

- To develop recommendations which might accelerate the implementation of GT.

- To assist in the development of an overall strategy regarding GT.

The overall project was divided into five phases. Phase I was a start-up phase to gain a general understanding of the range of GT application and interest at AMC, and review the planned activities for the project. Phase I also included the preparation of an Interest Survey to determine the facilities that were to participate in the overall assessment.

The purpose of Phase II, Preliminary Data Collection and Analysis, was to learn generally about current and planned GT activities, and to gain insight into potential opportunities and ramifications associated with GT. Phase II also included the analysis of the Interest Survey and the development of a Primary Questionnaire.

Phase III was used to acquire more comprehensive and specific data from GT users as well as non-users with GT potential. Phase III was also used to analyze the responses and prepare an action plan for on-site visits.

The purpose of Phase IV, On-Site Surveys and Analysis, was to acquire in-depth information concerning GT involvement, to develop an understanding of the opportunities, issues and ramifications, and to prepare a final report.

Phase V, Completion, was established to prepare and present an end-of-contract presentation.

In conjunction with the five preceding phases, administrative tasks, which included the preparation of performance and cost reports, the attendance at project meetings and the preparation of minutes, were also completed.

Project Work Schedule

The work schedule for accomplishing the five phases and providing the project deliverables was planned to require a fourteen month time frame. The project was begun on approximately November 1, 1983, with completion expected on December 31, 1984. However, despite the fact that expected delays had been built into the initial schedule, the waiting for the receipt of information from the various sites was greater than had been anticipated. The overall project required approximately two months longer than originally planned.

B. DISCUSSION

This section summarizes the overall findings of the assessment project. It deals with current GT interest and knowledge as well as Group Technology applications and plans. Also included is the information collected relating to investments and benefits.

Apparent GT Interest

In general, interest in Group Technology was found to be at a relatively low level. The majority of personnel contacted were either indifferent or negative toward any change in the status quo.

The Interest Survey was mailed to 47 organizations and 26 responded. Of these, only twelve agreed to continue participating in the project. Further, the lateness of this initial response caused at least two weeks delay in the analysis of the findings.

The second mailing, the Primary Questionnaire, was sent to 25 locations, seventeen of which replied. However, obtaining these replies delayed the project six weeks beyond what was initially planned. Further, the degree of completeness to the Primary Questionnaire was discouraging. Only five locations completed the section relating to Group Technology plans and experiences.

It became essential to begin the on-site visits before all the Primary Questionnaires were returned so as not to undergo even more serious delays in the completion of the project. Further, because very little information concerning GT was being received through the questionnaires, the outside visits were deemed to be critical to the value of the entire project. Over a five month period, fourteen sites were visited. In two cases, the individuals who agreed to the visit and established a date were no longer working at the facility when the visit was made.

One measure of GT interest revealed by the site visits was the number of people made available for individual discussions. At most locations, only 1 or 2 people were interviewed; at two locations, 13 - 14 people were interviewed. Interest in terms of documentation provided varied considerably at the locations as was the extent of touring of the facilities. These ranged from brief visits to isolated sections to complete tours of almost the entire operations.

A lack of top management interest was demonstrated by the fact that no high level personnel from the sub-commands, or even the individual locations, were actively involved in this project. Although nine locations have been identified as displaying a good interest in Group Technology, only at four of these locations was there a clear display of top management interest in GT. Where interest in GT was located, it was generally at a fairly low level in the structure or in a staff role.

GT Knowledge

It is evident that knowledge of the subject and experience in its use is significantly lacking at AMC. Without the background in GT philosophy, it is difficult to generate interest.

There is confusion in the definition of Group Technology. GT can be described as a concept, a philosophy or a strategy, but has been interpreted by some at AMC as a coding and classification system. These systems are merely tools used to readily form part families, either in design or manufacturing.

Another misconception is that GT requires a high investment. While sometimes a high investment is justified, there is usually no need to invest heavily in starting GT, and certainly not before a total plan is prepared which defines the ultimate objectives and the economic justification for the investment.

Other comments indicated that there is a dependency on outside consultants. Further, there is a false impression that GT can be utilized informally.

Only eight individuals responded to the portion of the questionnaire which requested information on GT knowledge and experience. These responses indicated that there is a significant lack of depth generally at AMC in GT knowledge and experience. Only five sites have been designated as having a somewhat dispersed knowledge of the subject.

Group Technology Experience

It appears that the first AMC investigations and studies in the field of Group Technology began in 1979 under the Manufacturing Methods and Technology (MMT) Programs. The Rock Island Arsenal, ARDC at Dover and the Watervliet Arsenal all began projects approximately at the same time. These projects used the resources of the Organization for Industrial Research and their MiClass Parts Classification and Coding System. All three locations also shared a contract with the Pennsylvania State University dealing with a Group Technology Scheduling Software Program. At least two of the projects appeared to be still open at the time of the on-site visits.

The next major thrust related to GT seems to have come through the Industrial Productivity Improvement (IPI) program. Avco Lycoming began their program in September 1981, and they are significantly along in the development of a Group Technology approach to the factory of the future. The Detroit and Lima Tank Plants operated by General Dynamics are now also participating in the IPI program and maintain that GT concepts will play an important role in their subsequent efforts.

The most recent impetus to the use of GT is the Depot Modernization Programs. Both Anniston and Tooele report that they are planning to use GT approaches in their improvement efforts. Corpus Christi has also related a serious interest in the field of Group Technology.

In summary, six of the fourteen organizations visited are studying or planning on the use of Group Technology, and three other locations have limited applications in place.

Classification and Coding

As mentioned earlier, Rock Island, Watervliet and ARDC at Dover have all been involved with the OIR MiClass Classification and Coding System. There were approximately an average of 3,000 parts coded at each of the three locations. The three locations, although using the same coding system, appeared to have been proceeding in different directions, and at none of the three locations were there any significant results reported from the programs.

In contrast, the Stratford Engine Plant developed an in-house system called OPSNET which identified part families that could be manufactured using common processes. It appears that the use of OPSNET produced significant results in a timely manner without a formal classification and coding system.

Cellular Manufacturing

Three locations (Lima, Anniston and Stratford) have cells either in operation or firmly planned. As part of a total relayout of the machining area at Lima, a cell was established. At Anniston an analysis revealed that two items have potential for cellular manufacturing. The processes for these two items were analyzed and one machine cell consisting of 12 machine tools was laid out to machine the parts. This project was started in 1981 and is scheduled for construction in 1986 with operation in 1987. At Stratford, the total factory is to be divided into a number of major manufacturing centers. Each of these centers is divided in turn into part family production lines or manufacturing cells. Excellent logic was used to determine the maximum cell size and the formation of equipment within the cell.

Other GT Plans

There is a wide variety of thoughts and ideas in various stages of formulation at AMC; however, there are no other clear applications of GT already in place or firmly planned.

For example, several locations have expressed a serious interest in Computer-Aided Process Planning (CAPP). The family of parts concept of GT provides the basis for pursuing this goal, but no

firm plans could be located which makes CAPP imminent. Stratford is hoping to introduce to its improvement programs in the future a major thrust into generative process planning. The current approach accepted the current processes as givens. It appears that Detroit's IPI program apparently will deal with improved process planning.

A number of individuals discussed the potential future use of computer-aided design activities. However, plans for the use of GT in product design are virtually nonexistent. There appears to be some desirability for a unified system of design utilizing a data base for all of AMC or even DoD.

Several individuals could envision the benefits of using GT in the procurement function. However, virtually no plans are underway to make this happen. It is believed that Detroit's proposed IPI program will include a material family analysis project which, among other features, addresses procurement by family rather than by individual part.

Other potential applications of GT principles included the design of new tools for parts required to be manufactured at depot repair locations. Also included would be the preparation of NC tapes for families of parts.

Investment and Benefits

Very little information was available concerning the amount of money invested in GT programs. Even less data was provided which concerns expected tangible results. Because few programs have been started and none have been completed, it was impossible to examine actual results.

It appears that $278,000 had been authorized for GT at the Rock Island Arsenal, and $536,500 for GT activities at ARDC Dover. No estimate of the authorized costs at Benet or Watervliet were obtained.

At Rock Island, OIR provided a report which projected the potential annual savings of nearly $2.4 million a year at Rock Island. In 1978, ARDC had estimated potential savings of $1.2 million annually at Dover.

The principles of GT are playing an important role in the major improvement effort at the Stratford Engine Plant. It is expected that $90 million will be spent over a four year period to make this facility the most cost efficient producer. There does not appear to be any doubt at the site that this investment will be cost justified.

C. CONCLUSIONS

This section summarizes the conclusions drawn from the findings of this project.

Current Efforts/Plans

The actual use of Group Technology in U.S. Army facilities is very limited. First hand observations have confirmed that, in general, the reported use of, or even plans for, Group Technology are somewhat exaggerated.

Some factors have been isolated which relate to those few applications that can be termed successful. These include: a compelling need, the development of in-house talent, the lack of a fascination with a canned technique, and a clear sense of direction. Similarly, where no success has been demonstrated, certain characteristics are evident. These efforts seem to depend too heavily on external parties without any strong internal leadership or ownership of the programs. They also tend to begin by classifying and coding parts without a clear indication of how the information would eventually be used. It can be concluded for the most part that a large amount of the funds expended for Group Technology by the U.S. Army have yet to yield a return.

Apparent Potential

It can be further concluded that there exists a significant potential for the selected use of Group Technology concepts in Army manufacturing facilities. The degree of potential use should be limited by the type of organization.

For example, arsenals and plants have opportunities for the use of Group Technology particularly in manufacturing cells. Part family routings, the standardization of process plans and Computer-Aided Process Planning all can be effectively utilized as well as tooling standardization and group NC tape applications. Depots which perform manufacturing and rework operations have opportunities also to develop cells for more efficient performance and faster throughput. However, there does not appear to be any significant potential for GT in manufacturing at the ammunition plants.

There is merit to the suggestion that there be a unified design data base, at least within AMC. This would require a major endeavor to achieve but it could be quite a beneficial undertaking. It would minimize new design efforts and foster component standardization.

Procurement is a virtually untapped opportunity. No efforts were observed which would lead to the purchase of part families rather than individual components. Economies could be achieved if all similar parts were brought together at the AMC or even initially at the facility level.

Issues and Ramifications

While it has been concluded that there exists a substantial potential for the use of GT principles at AMC, it is just as strongly concluded that there exists formidable obstacles which can hamper or even prevent meaningful accomplishment.

All efforts towards the effective use of Group Technology are doomed to failure without the understanding and support of top management. This is true not only at the local level but also at the AMC and sub-command levels. It is quite apparent that no higher level personnel had any significant influence on most of the existing programs. In addition to the lack of top management involvement, understanding and support of GT, it is apparent that there is also a lack of knowledge and experience in GT at the middle and lower levels of management. Major progress in GT implementation will require a strengthening of resources.

Another obstacle to progress in GT is the proposal and economic justification procedure. Procedures currently used for justification include the widespread use of traditional cost accounting methods. However, GT primarily attacks hidden cost elements where accurate accounting information is typically lacking. Further, it should be r cognized that the investment in GT can be minimal or substantial. The extent of that investment depends on the eventual goals that are anticipated. A feasibility study and a detailed development where warranted will provide plans and objectives that can provide an assessment of costs and benefits before a major commitment.

Other barriers to progress in GT are included within the organizational structure and its implications. For example, the routine transfer of military personnel at any level can affect unfavorably the momentum of a GT program. Further, GT by its nature, must cut across product lines in the functions of design, manufacturing and procurement. The program management concept may erect product line barriers which restrict the scope and potential of Group Technology. Finally, unless all who are affected and who will be using a proposed Group Technology approach are included in the planning and implementation of Group Technology, resistance towards change will continue to hamper progress.

D. RECOMMENDATIONS

A thorough analysis of the findings and a review of the conclusions reached during this project have resulted in the development of a number of important recommendations which are summarized in terms of objectives.

Improve Management Awareness

The achievement of this first objective is absolutely essential to all other actions that may be taken in the future with respect to Group Technology at AMC. Key decision makers and other top management personnel should gain an appreciation of GT so that they can independently evaluate its potential application. Confusion and misconceptions must be overcome and clarified. An awareness campaign led by someone of authority and influence should be started. The elements of the campaign should include the identification of key individuals, the determination of the degree of exposure to GT for each, and the development of techniques and materials to be used. The initial focus of this objective should be directed towards top and middle management. Education and training of lower level management personnel can await the acceptance of GT by top management.

Develop a GT Strategy

There needs to be a top down effort to complement the embryonic bottoms up effort that has begun in GT at AMC. It is recommended that a high level Steering Committee be established to determine future policies, provide direction and support, and monitor progress. The Steering Committee should determine the scope of effort of the GT program, provide priorities to the various elements and establish target dates for accomplishment. Several organizational issues need to be addressed concerning the staffing of GT efforts and the role of outside consultants. Additional key policy issues involve the requirements and procedures for the economic justification of specific GT projects. It is recommended that all efforts be preceded by a feasibility study and, if warranted, continue with a detail development phase prior to any expected implementation.

Commit Resources for Accomplishment

Assuming that an enthusiasm for the potential of GT has been generated and an overall strategy has been developed, the key toward GT progress is the commitment of resources. While some talent can be recruited, the numbers needed for meaningful progress will require a considerable effort in education and training of present personnel. In addition, top management will need to budget and approve the spending of funds to finance feasibility studies, detailed developments, and implementation programs. Finally, an essential ingredient in the GT program will be the degree of top management involvement. The greater the involvement, the greater the success. A very clear relationship exists.

Initiate Key Projects

The most fruitful projects will be those which are user initiated and management supported and not those which theoretically should provide substantial benefits. Therefore, it is recommended that an effort be made to identify certain potential areas of GT application which are endorsed by the users. These projects would include such things as pilot cell operations in plants, arsenals and depots; the initial development of a design data base; the standardization of process plans for CAPP; the use of part families in purchasing; and similar efforts.

Maintain Continuity

GT is a long-term commitment. It is necessary to develop an effective communications program to accompany the continuing efforts. Elements of such a program to maintain continuity could include such things as the establishment of an AMC GT center, a GT newsletter, a GT users group, the regular visibility of AMC top management associated with GT projects, and continuing educational courses in GT.

Expected Benefits

The use of Group Technology at the various U.S. Army organizations would provide substantial benefits and deserves further investigation and analysis. Quantifiable benefits could be expected to arise from reduced new parts designs, increased engineering productivity, reduced setup time, reduced tooling and expense, reduced work-in-process and reduced lead times. In addition, benefits which may not be quantifiable, but nonetheless real, would include reduced process planning time, reduced material handling expense and improved quality.

Considering the current pressures caused by ever increasing costs, it is recommended that each manager investigate Group Technology and its application to his environment within AMC.

APPENDIX 1

Cover Letter and Interest Survey Form

(7 Pages)

DEPARTMENT OF THE ARMY
US ARMY INDUSTRIAL BASE ENGINEERING ACTIVITY
ROCK ISLAND, ILLINOIS 61299

REPLY TO
ATTENTION OF

DRXIB-MT 5 JAN 1984

SUBJECT: Group Technology Interest Survey

SEE DISTRIBUTION

1. As part of an ongoing commitment to support and encourage the introduction of modern technologies into the operations of affiliate manufacturing facilities, the US Army Materiel Development and Readiness Command (DARCOM) is sponsoring a Group Technology (GT) Assessment. A contract for this assessment has been awarded to Case and Company.

2. GT is an approach to manufacturing which seeks to capitalize on item similarities to achieve significant economies. An overview describing the principles and benefits of GT is enclosed for your review. To date, a number of DARCOM organizations have made initial investments in isolated GT programs.

3. As you will note, this correspondence is being sent to a wide range of DARCOM organizations. The primary objectives of the total project are to assess DARCOM's current awareness and understanding and to analyze and help shape DARCOM's future plans with respect to GT.

4. It is planned that this assessment will include three expanding stages of data collection:

   1. An Interest Survey (enclosed).
   2. An Information Questionnaire.
   3. Representative On-Site Visits.

5. Your organization has been identified as a potential user of Group Technology. In this regard, we request your cooperation in the first stage of this assessment. Please expedite the rapid completion and return of the enclosed Interest Survey. It should take only a few minutes to complete. Completed survey forms should be returned as soon as possible, but no later than 10 February, to:

Mr. Raymond J. Levulis, Partner
Case and Company, Inc.
Prudential Plaza, Suite 2109
Chicago, Illinois 60601

6. Your cooperation, as expressed by prompt attention to this matter, can make a significant contribution to the knowledge gained from this assessment.

J. R. Gallaugher

2 Encl
as

J. R. GALLAUGHER
Director, USA Industrial Base
Engineering Activity

DRXIB-MT
SUBJECT: Group Technology Interest Survey 5 JAN 1984

DISTRIBUTION:

Major Subordinate Commands:
Cdr, US Army Armament, Munitions & Chemical Command, Attn: DRSMC-CG (R), Rock Island, IL 61299
Cdr, US Army Armament, Munitions & Chemical Command, Attn: DRSMC-CG (D), Dover, NJ 07801
Cdr, US Army Aviation Systems Command, Attn: DRSAV-CG, 4300 Goodfellow Blvd, St. Louis, MO 63120
Cdr, US Army Communications Electronics Command, Attn: DRSEL-CG, Ft. Monmouth, NJ 07703
Cdr, US Army Depot System Command, Attn: DRSDS-CG, Chambersburg, PA 17201
Cdr, US Army Electronics R&D Command, Attn: DRDEL-CG, 2800 Powder Mill Rd, Adelphi, MD 20983
Cdr, US Army Missile Command, Attn: DRSMI-CG, Redstone Arsenal, AL 35898
Cdr, US Army Tank-Automotive Command, Attn: DRSTA-CG, Warren, MI 48090
Cdr, US Army Test & Evaluation Command, Attn: DRSTE, Aberdeen Proving Ground, MD 21005
Cdr, US Army Troop Support Command, Attn: DRSTR-CO, 4300 Goodfellow Blvd, St. Louis, MO 63120

Army Ammunition Plants:
Cdr, Crane AAA, Attn: SMCCN-CO, Crane, IN 47522
Cdr, Hawthorne AAP, Attn: SMCHW-CO, Hawthorne, NV 89415
Cdr, Iowa AAP, Attn: SMCIO-CO, Middletown, IA 52638
Cdr, Kansas AAP, Attn: SMCKA-CO, Parsons, KS 67357
Cdr, Lake City AAP, Attn: SMCLC-CO, Independence, MO 64050
Cdr, Lone Star AAP, Attn: SMCLS-CO, Texarkana, TX 75501
Cdr, Longhorn AAP, Attn: SMCLO-CO, Marshall, TX 75670
Cdr, Louisiana AAP, Attn: SMCLA-CO, Shreveport, LA 71130
Cdr, McAlester AAP, Attn: SMCMC-CO, McAlester, OK 74501
Cdr, Milan AAP, Attn: SMCMI-CO, Milan, TN 38358
Cdr, Mississippi AAP, Attn: SMCMS-CO, Picayune, MS 39466
Cdr, Riverbank AAP, Attn: SMCRB-CR, Riverbank, CA 95356
Cdr, Scranton AAP, Attn: SMCSC-CO, Scranton, PA 18501

Depots:
Cdr, Anniston Army Depot, Attn: SDSAN-CO, Anniston, AL 36201
Cdr, Corpus Christi Army Depot, Attn: SDSCC-CO, Corpus Christi, TX 78419
Cdr, Letterkenny Army Depot, Attn: SDSLE-CO, Chambersburg, PA 17201
Cdr, Mainz Army Depot, Attn: SDSMZ-CO, APO New York, NY 09185
Cdr, New Cumberland Army Depot, Attn: SDSNC-CO, New Cumberland, PA 17070
Cdr, Pueblo Army Depot Activity, Attn: SDSTE-PU, Pueblo, CO 81001
Cdr, Red River Army Depot, Attn: SDSRR-CO, Texarkana, TX 75501
Cdr, Sacramento Army Depot, Attn: SDSSA-CO, Sacramento, CA 95813
Cdr, Savanna Army Depot Activity, Attn: SDSLE-SV, Savanna, IL 61074
Cdr, Seneca Army Depot, Attn: SDSSE-CO, Romulus, NY 14541
Cdr, Sharpe Army Depot, Attn: SDSSH-CO, Lathrop, CA 95331
Cdr, Sierra Army Depot, Attn: SDSSI-CO, Herlong, CA 96113
Cdr, Tobyhanna Army Depot, Attn: SDSTO-CO, Tobyhanna, PA 18466
Cdr, Tooele Army Depot, Attn: SDSTE-CO, Tooele, UT 84074

DRXIB-MT
SUBJECT: Group Technology Interest Survey

5 JAN 1984

DISTRIBUTION (Cont'd):

Arsenals:
Cdr, Rock Island Arsenal, Attn: SMCRI-CO, Rock Island, IL 61299
Cdr, Watervliet Arsenal, Atttn: SMCWV-CO, Watervliet, NY 12189

Laboratories:
Cdr, Benet Weapons Laboratory, Attn: DRSMC-LCB-S, Watervliet, NY 12189

Other Government Owned Plants:
Cdr, Stratford Army Engine Plant, Attn: DCASPRO, 550 S. Main St., Stratford, CT 06497
Cdr, Lima Army Tank Center, Attn: DRSTA-XL, 1155 Buckeye Rd., Lima, OH 45804
Cdr, Detroit Army Tank Plant, Attn: DRCPM-M60-T, 28251 Van Dyke Ave., Warren, MI 48090

Other Government Activities:
Dir, US Army Materials and Mechanics Research Center, Attn: DRXMR-PP, Watertown, MA 02172
Cdr, Munitions Production Base Modernization Agency, Attn: SMCPM-PBM-DP, Dover, NJ 07801
Cdr, Belvoir Research & Development Center, Attn: STRBD-Z, Ft. Belvoir, VA 22060
Cdr, Natick Research & Development Center, Attn: STRNC-Z, Natick, MA 01760

CF:
Cdr, US Army Materiel Development & Readiness Command, Attn: DRCMT, 5001 Eisenhower Avenue, Alexandria, VA 22333
Cdr, US Army Materiel Development & Readiness Command, Attn: DRCPP, 5001 Eisenhower Avenue, Alexandria, VA 22333

DARCOM

GROUP TECHNOLOGY INTEREST SURVEY

The purpose of this interest survey is to determine which organizations would like to participate in the Group Technology Assessment conducted by Case and Company for DARCOM. Organizations which choose to participate should name specific individuals and supply appropriate contact information. It is estimated that the next stage of data collection, the Information Questionnaire, would require no more than two-three hours to complete.

Some of the questions on this form may not be applicable. If so, please indicate with N/A. Also, feel free to attach additional information to this form that you believe would be helpful to this survey.

SECTION 1. General Information

1.1 Identification

1.11 Organization Name____________________________

1.12 Organization Location__________________________

____

1.13 Respondent Name____________________________

1.14 Respondent Title___________________________

1.15 Telephone(___)______________ 1.16 Date__________

1.2 Organization Description

1.21 Briefly describe the output of this organization. Discuss types of products, annual volume, make versus buy, degree of commonality, product stability, and similar characteristics and features.

____

____

____

____

____

____

____

____

____

____

1.22 Briefly describe the manufacturing function of this organization. Discuss the manufacturing processes used, space utilized, make to order/stock, mass production versus batch or job shop, manufacturing technologies/systems employed, etc.

1.23 Estimate the number of current employees as:

1.231 Direct Labor ______
1.232 Indirect Labor ______
1.233 Others in Manufacturing ______
1.234 Others in Organization ______
1.235 Total ______

1.24 Provide any other information that you feel would be helpful in understanding this organization in a general manner.

SECTION 2. Group Technology

2.1 Have you heard of Group Technology prior to this communication? ☐ Yes ☐ No

2.2 Is GT being used, or planned to be used, at this organization? ☐ Yes ☐ No

2.21 If Yes, how? ________________________________

2.3 Do you believe that this organization is a potential user of GT? ☐ Yes ☐ No ☐ Not Certain

2.31 If No, why not? ________________________________

2.4 Would you like this organization to participate in the DARCOM GT Assessment? ☐ Yes ☐ No ☐ Not Certain

2.41 If Not Certain, explain: ________________________________

2.42 If Yes, provide the names and contact information of the individuals who would participate in the subsequent data collection stages:

Name	Title	Responsibility*	Address or Telephone if Different

*General Management, Manufacturing, Product Design, Purchasing, Logistics, etc.

2.5 Are you aware of any other DARCOM organizations, that are not indicated on the distribution for this correspondence, that should have been included in this Interest Survey? ☐ Yes ☐ No

2.51 If Yes, which? ______________________________

____

____

____

____

____

____

RETURN COMPLETED SURVEY FORM BY FEBRUARY 10, 1984, TO:
MR. RAYMOND J. LEVULIS, PARTNER CASE AND COMPANY, INC. PRUDENTIAL PLAZA, SUITE 2109 CHICAGO, ILLINOIS 60601

APPENDIX 2

Cover Letter and Primary Questionnaire

(26 Pages)

Case and Company, Inc.

Consultants to Management

New York Stamford Chicago Los Angeles

April 27, 1984

Mr. Eldon Collett
Industrial Engineer
AMCCOM
Attn: DRSMC-IRW-T(R)
Rock Island, Illinois 61299

Dear Mr. Collett:

We have received, and appreciate, the response from your organization to the DARCOM Group Technology Interest Survey. We are pleased that you have decided to continue to participate in the GT Assessment.

Accordingly, we have included the Primary Questionnaire to be completed by your organization. As you may recall, this step represents the second phase of the Assessment. The next step, Phase III, will consist of on-site visits to a number of locations. These visits will be made at no cost to the participating organizations.

The Primary Questionnaire contains several sections. Please complete, or have the appropriate individuals from your organization complete, all sections that are relevant to your organization. Duplicate the blank sections as required if the particular function is performed at more than one location in your organization. The following are enclosed:

- Section 1 - General Information
- Section 2 - Manufacturing/Repair Function
- Section 3 - Design Function
- Section 4 - Purchasing Function

Section 5 is included only if your organization had previously indicated that Group Technology has been applied, or is planning to be applied. Section 6 is included only if your organization had indicated any prior knowledge of Group Technology.

It is not necessary to duplicate any detailed supplemental information sent to us previously such as an extended description of your activities.

Please return the completed Primary Questionnaire to me at the above address at your earliest convenience and before May 25, 1984. If you have any questions, feel free to call me at (312) 861-0994.

Thank you for your cooperation in this matter.

Sincerely,

Raymond J. Levulis CMC
Senior Partner

SAMPLE "B" LETTER

Case and Company, Inc.
Suite 2109
Prudential Plaza
Chicago IL
60601
Telephone
312 861-0994
Telex [illegible]

Consultants to Management
New York
Stamford
Chicago
Los Angeles

April 27, 1984

Mr. Richard Koppenaal
Chief, Industrial and Technical
  Branch
AMCCOM
Munitions Production Base Mod. Agency
Attn: SMCPM-PBM-TI
Dover, New Jersey 07801

Dear Mr. Koppenaal:

We have received, and appreciate, the response from your organization to the DARCOM Group Technology Interest Survey. The response indicated that you were uncertain regarding continued participation in the GT Assessment. After a review of the material forwarded to us, we believe that it is in your best interest to participate in the next level of data collection for this Assessment.

Accordingly, we have included the Primary Questionnaire to be completed by your organization. As you may recall, this step represents the second phase of the Assessment. The next step, Phase III, will consist of on-site visits to a number of locations. These visits will be made at no cost to the participating organizations.

The Primary Questionnaire contains several sections. Please complete, or have the appropriate individuals from your organization complete, all sections that are relevant to your organization. Duplicate the blank sections as required if the particular function is performed at more than one location in your organization. The following are enclosed:

Section 1 - General Information
Section 2 - Manufacturing/Repair Function
Section 3 - Design Function
Section 4 - Purchasing Function

Section 5 is included only if your organization had previously indicated that Group Technology has been applied, or is planning to be applied. Section 6 is included only if your organization had indicated any prior knowledge of Group Technology.

Affiliates
Europe
Middle East Far East
South America

Member
ACME An association
of leading management
consulting firms

Mr. Richard Koppenaal
AMCCOM

April 27, 1984
Page 2

It is not necessary to duplicate any detailed supplemental information sent to us previously such as an extended description of your activities.

Please return the completed Primary Questionnaire to me at the above address at your earliest convenience and before May 25, 1984. If you have any questions, feel free to call me at (312) 861-0994.

Thank you for your cooperation in this matter.

Sincerely,

Raymond J. Levulis CMC
Senior Partner

RETURN COMPLETED QUESTIONNAIRE TO:

MR. RAYMOND J. LEVULIS
SENIOR PARTNER
CASE AND COMPANY, INC.
PRUDENTIAL PLAZA, SUITE 2109
CHICAGO, ILLINOIS 60601

DARCOM

PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

A. Supervisory/Support Organizations

SECTION 1. General Information

1.1 Identification

1.11 Organization Name ______________________

1.12 Organization Location ______________________

____

1.13 Respondent Name ______________________

1.14 Respondent Title ______________________

1.15 Telephone( ) ______________ 1.16 Date ______________

1.2 Mission

1.21 Briefly, describe the mission of this organization ______

____

____

____

____

____

____

1.22 List below all organizations within this Command which this organization provides direct support relating to manufacturing, rework, design or purchasing.

____

____

____

____

____

____

____

(For each organization listed above, please make appropriate number of blank copies and complete a separate Section 2, 3 and/or 4 as applicable.)

1.3 Group Technology

1.31 List below all organizations within this Command which are using or planning to use Group Technology.

____
____
____
____
____
____

(For each organization listed above, please make appropriate number of blank copies and complete Section 5.)

1.32 Has Group Technology ever been considered and discarded by any organization within this Command? ☐ Yes ☐ No

1.321 If Yes, which organization(s)?____________________
____
____

1.322 If Yes, was it investigated for applications in:

☐ Manufacturing
☐ Design
☐ Purchasing

1.323 If Yes, why was it discarded?____________________
____
____
____
____

1.4 Please complete Section 6 of this questionnaire.

RETURN COMPLETED QUESTIONNAIRE TO:
MR. RAYMOND J. LEVULIS SENIOR PARTNER CASE AND COMPANY, INC. PRUDENTIAL PLAZA, SUITE 2109 CHICAGO, ILLINOIS 60601

DARCOM

PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

B. Depots and Plants

SECTION 1. General Information

1.1 Identification

1.11 Organization Name ____________________
1.12 Organization Location ____________________
____
1.13 Respondent Name ____________________
1.14 Respondent Title ____________________
1.15 Respondent Organization ____________________
1.16 Telephone( ) ____________ 1.17 Date ____________

1.2 Mission

1.21 Briefly describe the mission of this organization: _____
____
____
____
____
____

1.22 Check off which of the following functions are performed at this location:

1.221 Manufacturing/Rework ☐
1.222 Design ☐
1.223 Purchasing ☐

(Complete Sections 2, 3, and/or 4 for the functions checked above.)

1.3 Group Technology

1.31 Mark the activity that describes the use of GT at this organization for the functions listed:

	No Activity	Under Consideration	Being Planned	Limited Installation	Major Installation
1.311 Manufacturing	☐	☐	☐	☐	☐
1.312 Product Design	☐	☐	☐	☐	☐
1.313 Purchasing	☐	☐	☐	☐	☐
1.314 Other________	☐	☐	☐	☐	☐

(If any function above is being planned, or has installed GT, complete Section 5.)

1.32 If GT has been installed, have the tangible benefits exceeded the cost of the program?

1.321 ☐ Not Applicable ☐ Yes ☐ No

1.322 If no, are they expected to in the future?
☐ Yes ☐ No

1.323 If Yes, when?________________________________

1.33 Overall, are you satisfied with:

1.331 The performance of GT here? ☐ Yes ☐ No

1.332 The rate of progress? ☐ Yes ☐ No

1.34 Has Group Technology ever been considered and discarded at this location? ☐ Yes ☐ No

1.341 If Yes, was it investigated for application in:

☐ Manufacturing
☐ Design
☐ Purchasing

1.342 If Yes, why was it discarded?________________

____
____
____
____
____

1.4 Please complete Section 6 of This Questionnaire.

RETURN COMPLETED QUESTIONNAIRE TO:
MR. RAYMOND J. LEVULIS SENIOR PARTNER CASE AND COMPANY, INC. PRUDENTIAL PLAZA, SUITE 2109 CHICAGO, ILLINOIS 60601

DARCOM

PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

SECTION 2. Manufacturing/Repair Function

2.1 Identification

2.11 Organization Name ____________________

2.12 Organization Location ____________________

____

2.13 Respondent Name ____________________

2.14 Respondent Title ____________________

2.15 Respondent Organization ____________________

2.16 Telephone ( ) ____________ 2.17 Date ____________

2.2 Employment Levels

2.21 Estimate the number of current employees:

2.211 Direct Labor ________ 2.213 Other ________

2.212 Indirect Labor ________ 2.214 Total ________

2.22 Are any of the employees members of a union?

☐ Yes ☐ No

2.221 If Yes, what percent? ____________________

2.222 If Yes, what Union(s)? ____________________

____

2.3 Manufacturing Function

2.31 Briefly describe the major manufacturing processes at the facility (i.e. assembly, welding, machining, etc.).

____

____

____

____

____

2.32 Approximately how much space (in square feet) is devoted to the manufacturing function? ____________________

____

2.33 Check and comment on any of the following techniques/ technologies/systems that are used, or planned to be used:

2.331 Numerical Control (NC)(CNC)(DNC) ☐ ________

2.332 Computer Integrated Manufacturing (CIM) ☐ ________

2.333 Computer Aided Manufacturing (CAM) ☐ ________

2.334 Flexible Manufacturing Systems (FMS) ☐ ________

2.335 Computer Aided Process Planning (CAPP) ☐ ________

2.336 Robotics ☐ ________

2.337 Materials Requirements Planning (MRP) ☐ ________

2.338 Manufacturing Resource Planning (MRPII) ☐ ________

2.339 Quality Circles ☐ ________

2.340 Wage Incentives ☐ ________

2.341 Profit Sharing ☐ ________

2.342 Job Enrichment/Enlargement ☐ ________

2.343 Flex Time ☐ ________

Additional comments relating to above: ________________

2.34 Other manufacturing technologies/systems used or planning to be used, not listed above? ________________

2.35 Check and comment on any that describe this facility:

- 2.351 Mass production ☐ ______
- 2.352 Batch production ☐ ______
- 2.353 Rework/rehabilitation/repair ☐ ______
- 2.354 Job shop ☐ ______
- 2.355 Make to order ☐ ______
- 2.356 Make to stock ☐ ______
- 2.357 Assemble to order ☐ ______

2.4 Customers

2.41 Identify any DARCOM entities that are your customers:

Organization Name	Product Sold	Approximate % of Total Output

2.42 Identify any other DOD entities that are your customers:

Organization Name	Product Sold	Approximate % of Total Output

2.5 Other Information

2.52 Is there any other information which would be helpful in understanding the manufacturing/repair function in a general manner?

______
______
______
______
______
______
______
______

RETURN COMPLETED QUESTIONNAIRE TO:
MR. RAYMOND J. LEVULIS SENIOR PARTNER CASE AND COMPANY, INC. PRUDENTIAL PLAZA, SUITE 2109 CHICAGO, ILLINOIS 60601

DARCOM

PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

SECTION 3. Design Function

3.1 Identification

3.11 Organization Name ____________________

3.12 Organization Location ____________________

____

3.13 Respondent Name ____________________

3.14 Respondent Title ____________________

3.15 Respondent Organization ____________________

3.16 Telephone ( ) ____________ 3.17 Date ____________

3.2 Design Function

3.21 Does this facility design end products? ☐ Yes ☐ No

3.211 If No, who provides design? ____________________

____

____

____

3.22 Does this facility design components? ☐ Yes ☐ No

3.221 If No, who provides design? ____________________

____

____

____

3.23 How many people are employed in the product design function? ____________________

3.231 List approximate number by titles:

TITLES	NUMBER

3.24 Is Computer Aided Design (CAD) used in this facility?
☐ Yes ☐ No

3.241 If No, is it being contemplated? ☐ Yes ☐ No

3.242 If not, why not?______________________________

3.243 If used, when was it implemented?______________

3.44 If used or contemplated, what benefits have been realized or expected?______________________________

3.3 Product Line

3.31 In the past 12 months, approximately how many of the following were released?

3.311 New end products______________

3.312 New purchased components______________

3.313 New manufactured components______________

3.32 In the current product line, estimate the number of the following:

3.321 End products______________

3.322 Purchased components______________

3.323 Manufactured components______________

3.33 In general, how would you rate the product line?

3.331 ☐ Very stable

3.332 ☐ Very unstable

3.333 ☐ Somewhere in between

3.34 In general, how would you rate the degree of component commonality between the end products?

3.341 ☐ Very little commonality

3.342 ☐ Some degree of commonality

3.343 ☐ High degree of commonality

3.4 Other Information

3.41 Is there any other information which would be helpful in generally understanding the design function at this location?______________________________

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DARCOM

PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

SECTION 4. Purchasing Function

4.1 Identification

4.11 Organization Name ____________________

4.12 Organization Location ____________________

____

4.13 Respondent Name ____________________

4.14 Respondent Title ____________________

4.15 Respondent Organization ____________________

4.16 Telephone( ) ____________ 4.17 Date ____________

4.2 Purchasing Function (Omit any data below relating to purchased services.)

4.21 Briefly describe the major production items purchased at this facility (i.e. electronic components, bearings, castings, etc.): ____________________

____

____

____

4.22 Check and comment on any that relate to the purchasing function at this facility:

4.221 Purchase to forecast ☐ ____________

4.222 Purchase to order ☐ ____________

4.223 Use MRP systems ☐ ____________

4.224 Use EOQ ☐ ____________

4.225 Use blanket orders ☐ ____________

4.226 Formal vendor evaluation ☐ ____________

4.23 Are any major production items purchased for this facility through another location? ☐ Yes ☐ No

4.231 If Yes, where? ____________________

4.232 If Yes, what? ____________________

4.24 How many people are employed in the purchasing function?

____

4.241 List approximate number by titles:

TITLE	NUMBER

4.25 Approximately how many different production items are purchased annually? _______________

4.26 What is the approximate dollar volume of these annual purchases? _______________

4.27 Approximately how many new items were purchased in the past twelve months? _______________

4.28 In general, how would you rate the degree of item "similarity" (potential families of items) among the items purchased?

4.281 ☐ Very little similarity

4.282 ☐ Some degree of similarity

4.283 ☐ High degree of similarity

4.3 Suppliers

4.31 Approximately how many different suppliers are used for the items purchased? _______________

4.32 Approximately what percent of the items are single sourced? _______________

4.33 Identify any DARCOM entities that are your suppliers:

Organization Name	Product Purchased	Approximate % of Total Purchases

4.34 Identify any other DOD entities that are your suppliers:

Organization Name	Product Purchased	Approximate % of Total Purchases

4.4 Other Information

4.41 Is there any other information which would be helpful in generally understanding the purchasing function at this organization?

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PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

SECTION 5. GT Plans and Experiences

This section is divided into three parts. Please complete the appropriate part(s) for this organization:

5.1 GT Plans/Experience - Manufacturing
5.2 GT Plans/Experience - Design
5.3 GT Plans/Experience - Purchasing

5.1 GT Plans/Experience - Manufacturing

5.11 Identification

5.111 Organization Name____________________

5.112 Organization Location____________________

____

5.113 Respondent Name____________________

5.114 Respondent Title____________________

5.115 Respondent Organization____________________

5.116 Telephone(___)__________ 5.117 Date__________

5.12 When was GT in manufacturing first introduced or planned to be introduced into this organization?__________

5.121 When was, or is the GT program scheduled to be fully implemented?__________

5.13 Check all of the uses of GT in manufacturing that describes how it is applied, or is planned to be applied, at this organization:

5.131 Cellular manufacturing ☐
5.132 Standard routing of part families ☐
5.133 Computer-aided process planning ☐
5.134 Common tooling for part families ☐
5.135 Family sequencing to reduce setup time ☐
5.136 Production scheduling of families ☐
5.137 Determine capital equipment needs ☐
5.138 Improve quality of production ☐
5.139 Job enlargement ☐

5.14 Is GT used, or planned to be used in manufacturing, in any way not covered by the above listing? ☐ Yes ☐ No

5.141 If Yes, describe: ______________________

5.142 Describe any potential applications in manufacturing for GT that are not being used or planned to be used: ______________________

5.15 If cellular manufacturing was checked under 5.13, complete the following. If it was not checked, go to 5.16.

5.151 How many cells are:

5.1511 Currently in operation? __________

5.1512 Planned to be in operation? __________

5.152 What is your estimate of the percentage of this facility's workload which will be produced in cells? __________

5.153 Describe the items which are produced, or will be produced, in cells: ______________________

5.154 What is the quantity of machine tools:

5.1541 Typically in cell? __________

5.1542 Smallest cell? __________

5.1543 Largest cell? __________

5.1544 List the types of machine tools which are found in the typical cell: ______________________

5.155 If the number of cells, types of machine tools per cell or the types of parts produced in the cells has changed significantly since you first began using cells, please describe what changes were undertaken, and why these changes were made: ______________________

5.156 Please describe how the production cells were formed. In particular, how were machines to be included in a cell identified? How were the parts which would be produced in the cells identified?

5.1561 Describe any problems encountered in setting up the production cells:

5.1562 How were these problems overcome?

5.157 Typical number of operators per cell

5.1571 Greatest number of operators in a cell

5.1572 Smallest number of operators in a cell

5.1573 How are wages determined for operators working in cells?

5.1574 If this is any different than the manner in which wages were determined prior to the implementation of cells, please explain how it is different.

5.1575 Describe any labor-related problems you have encountered, or anticipate, in conjunction with the change to, and/or operation, of the production cells.

5.158 How is supervision for the cell(s) organized?

5.1581 ☐ There is one supervisor (foreman) per cell

5.1582 ☐ Supervision is by type of machine (for example, one individual is responsible for all the lathes in all cells)

5.1583 ☐ Other, please describe:

5.1584 If there is one supervisor (foreman) per cell, explain how supervisors were selected for the cells.

5.159 Describe any other problems you have encountered related to the operation of production cells.

5.1591 How have you overcome (or attempted to overcome) the difficulties mentioned above?

5.16 For the other uses checked in 5.13, briefly describe the application, its extent and limits, and any problems and their resolution.

AD-A152 045 GROUP TECHNOLOGY ASSESSMENT: US ARMY MATERIEL COMMAND (U) CASE AND CO INC CHICAGO IL R J LEVULIS JAN 85 SBI-AD-E700 016 DAAA09-83-C-4915 2/2

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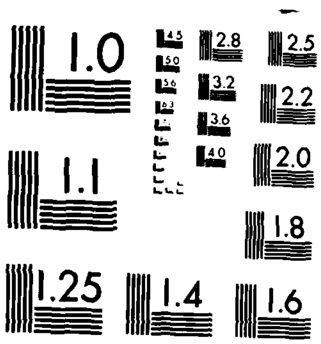

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

5.17 Are you currently using, or contemplating the use of, a classification and coding system for GT in manufacturing?
☐ Yes ☐ No

5.171 If Yes, ☐ in-house ☐ commercial

5.172 If commerncial, which one:____________________

____

5.173 How many items are coded?____________________

5.174 How many items are to be coded?________________

5.175 If you do not use, or plan to use, a classification and coding system, briefly explain why not.

____

____

____

____

____

5.18 What were the prime motivations for using GT in manufacturing?______________________________

____

____

5.181 What benefits have been realized, or are expected from the GT program in manufacturing?__________

____

____

5.182 Have any expected benefits not been realized?
☐ Yes ☐ No

5.1821 If Yes, why not?____________________

____

____

5.19 List below the names of others in the manufacturing function who are, were, or will be, involved in the GT program:

Name	Title	Scope of Responsibility

5.2 GT Plans/Experience - Design

5.21 Identification

5.211 Organization Name________________________

5.212 Organization Location________________________

____

5.213 Respondent Name________________________

5.214 Respondent Title________________________

5.215 Respondent Organization________________________

5.216 Telephone(   )__________ 5.217 Date__________

5.22 When was GT in design first introduced, or planned to be introduced, into this organizaton?__________

5.221 When was it fully implemented, or scheduled to be fully implemented?__________

5.23 Check the uses of GT in design that describes how it is applied, or is planned to be applied, at this organization:

5.231 Aid the design of new parts ☐

5.232 Expedite the release of new parts ☐

5.233 Reduce the variety of design ☐

5.234 Used in conjunction with CAD ☐

5.235 Retrieve existing designs ☐

5.236 Used to assist CAPP ☐

5.24 Is GT used, or planned to be used in design, in any way not covered by the above listing? ☐ Yes ☐ No

5.241 If Yes, describe:________________________

____

____

5.242 Describe any potential applications in design for GT that are not being used or planned to be used:________________________

____

____

5.25 For the uses checked above in 5.23, briefly describe the application, its extent and limits.__________

____

____

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____

____

5.26 What problems have you encountered, or expect to encounter, in attempting to apply GT to the design function?

____

5.261 How have you or how are you planning to overcome these problems?________________

5.27 Are you currently using, or contemplating the use of, a classification and coding system for GT in design?
☐ Yes ☐ No

5.271 If Yes, ☐ in-house ☐ commercial

5.272 If commercial, which one:________________

5.273 How many items are coded?________________

5.274 How many items are to be coded?________________

5.275 If you do not use, or plan to use, a classification and coding system, briefly explain why not.

____

5.28 What were the prime motivations for using GT in design?

____

5.281 What benefits have been realized, or are expected, from the GT program in design?________________

5.282 Have any expected benefits not been realized?
☐ Yes ☐ No

5.2821 If Yes, why not?________________

5.29 List below the names of others in the design function who are, were, or will be, involved in the GT program:

Name	Title	Scope of Responsibility

5.3 GT Plan/Experience - Purchasing

5.31 Identification

5.311 Organization Name__________

5.312 Organization Location__________

5.313 Respondent Name__________

5.314 Respondent Title__________

5.315 Respondent Organization__________

5.316 Telephone(   )______ 5.137 Date__________

5.32 When was GT in purchasing first introduced, or planned to be introduced, into this organization?__________

5.321 When was it fully implemented, or scheduled to be fully implemented?__________

5.33 Describe specifically how GT has been, or is planned to be, applied to the purchasing function at this organization:__________

5.34 Briefly describe any other potential application of GT in purchasing which could be pursued at this organization:

5.35 What problems have you encountered, or expect to encounter, in attempting to apply GT to the purchasing function?__________

5.351 How have you or how are you planning to overcome these problems? ____________________

____

____

5.36 Are you currently using, or contemplating the use of, a classification and coding system for GT in purchasing?
☐ Yes ☐ No

5.361 If Yes, ☐ in-house ☐ commercial

5.362 If commerical which one: ____________________

____

5.363 How many items are coded? ____________________

5.364 How many items are to be coded? ____________________

5.365 If you do not use, or plan to use, a classification and coding system, briefly explain why not.

____

____

____

____

____

____

5.37 What were the prime motivations for using GT in purchasing? ____________________

____

____

5.371 What benefits have been realized, or are expected, from the GT program in purchasing? ____________________

____

____

5.372 Have any expected benefits not been realized?
☐ Yes ☐ No

5.3721 If Yes, why not? ____________________

____

____

5.38 List below the names of others in the purchasing function who are, were, or will be, involved in the GT program:

Name	Title	Scope of Responsibility

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PRIMARY QUESTIONNAIRE - GROUP TECHNOLOGY

SECTION 6. Individual GT Knowledge

6.1 Identification

6.11 Organization Name ______________________________

6.12 Organization Location ______________________________

____

6.13 Respondent Name ______________________________

6.14 Respondent Title ______________________________

6.15 Respondent Organization ______________________________

6.16 Telephone(   ) ______________ 6.17 Date ____________

6.2 Individual Knowledge

6.21 Had you ever heard of Group Technology before this assessment began? ☐ Yes ☐ No(If No, Section 6 is completed.

6.22 Check the description which best captures the degree of your familiarity:

- 6.221 Had merely heard of the term ☐
- 6.222 Had a vague understanding ☐
- 6.223 Somewhat familiar with concepts ☐
- 6.224 Had a working familiarity ☐
- 6.225 Am very knowledgeable ☐
- 6.226 Consider myself an expert ☐

6.23 Check all the sources below which caused your familiarity with GT:

- 6.231 Have heard presentations ☐
- 6.232 Have attended GT Conferences ☐
- 6.233 Have read about GT ☐
- 6.234 Heard about from colleagues ☐
- 6.235 Visited GT installations ☐
  (where: ______________________________)
- 6.236 GT was used where I worked ☐
  (where: ______________________________)
- 6.237 Was directly involved in a GT program ☐
  (where: ______________________________)
- 6.238 Other ☐
  (what: ______________________________)

APPENDIX 3

Individuals Interviewed During On-Site Visits

(5 Pages)

INDIVIDUALS INTERVIEWED DURING ON-SITE VISITS

Name/Title	Organization/Location
Mr. Nathaniel Scott Industrial Engineer	AMCCOM-ARDC Dover, New Jersey
Mr. Donald O'Connor Mechanical Engineer	AMCCOM-ARDC Dover, New Jersey
Major Walter W. Olson CAD/CAM/GT Project Manager	Benet Weapons Laboratory Watervliet, New York
Ms. Dawna Mayorga Industrial Engineer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Joseph Mikita Industrial Engineer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. W. Franklin Wilbur Industrial Engineer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Jack Brooks Chief, PPM Division	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Larry Davis Work Measurement Branch	Corpus Christi Army Depot Corpus Christi, Texas
Major H. H. Alvarado Logistics Officer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Jerry New Chief, PPC Division	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Eulalio Elizondo Chief, Manufacturing Planning Branch	Corpus Christi Army Depot Corpus Christi, Texas
Mr. E. V. Garcia Engineering Design Branch	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Kreston Cook Engineering Branch	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Scott Sanson Engineering Branch	Corpus Christi Army Depot Corpus Christi, Texas

Name/Title	Organization/Location
Mr. Harry Kuebler Supervisor, Machining	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Paul Howard Process Engineer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Leo Brents Process Engineer	Corpus Christi Army Depot Corpus Christi, Texas
Mr. Dwight Byrd Chief, Production Engineering Division	Red River Army Depot Texarkana, Texas
Mr. Kenneth C. Kingston Chief, Production Inspection Branch	Red River Army Depot Texarkana, Texas
Mr. R. H. Boyd Supervising Industrial Engineer, Modernization and Equipment Planning Branch	Red River Army Depot Texarkana, Texas
Mr. William A. Richardson General Engineer	Red River Army Depot Texarkana, Texas
Mr. John D. Wilkins Industrial Engineer	Rock Island Arsenal Rock Island, Illinois
Mr. M. J. Sievers NC Tooling Technician Foreman	Rock Island Arsenal Rock Island, Illinois
Mr. Scott Macomber Chief, Industrial Management Office	Rock Island Arsenal Rock Island, Illinois
Mr. Edwin H. Rathjen, Jr. Industrial Specialist	Rock Island Arsenal Rock Island, Illinois
Mr. Howard Husson Chief, Methods & Standards Branch	Rock Island Arsenal Rock Island, Illinois

Name/Title	Organization/Location
Mr. Ernest Vince Industrial Engineer	DCASPRO Avco Lycoming Division
Mr. Joe T. Potts, Jr. Chief, Production and Engineering Branch	DCASPRO Avco Lycoming Division
Mr. Douglas T. Mears Director, IPI and Capacity Engineering Support	Avco Lycoming Division Stratford, Connecticut
Mr. Michael Propen Manager, Computer Aided Technology	Avco Lycoming Division Stratford, Connecticut
Mr. Joseph L. Vicidomino Contracts Administrator	Avco Lycoming Division Stratford, Connecticut
Mr. Charles L. Turcotte MM&T Coordinator	Avco Lycoming Division Stratford, Connecticut
Mr. E. G. Morgado Manager of Procurement	Avco Lycoming Division Stratford, Connecticut
Mr. F. D. Hyatt Program Manager, Modernization	Avco Lycoming Division Stratford, Connecticut
Mr. Norman Miller Project Manager, IPI Manufacturing Services	Avco Lycoming Division Stratford, Connecticut
Mr. Donald P. Smart Manager, Casting and Forging Technology	Avco Lycoming Division Stratford, Connecticut
Mr. John Jacko Project Leader, Applications	Avco Lycoming Division Stratford, Connecticut
Mr. Tom Rook Supervisor, CAD	Avco Lycoming Division Stratford, Connecticut
Mr. John Smith, III Design Supervisor	Avco Lycoming Division Stratford, Connecticut
Mr. W. J. Costello IPI Program Chief	General Dynamics Land Systems Division Warren, Michigan

Name/Title	Organization/Location
Mr. Stanley Sylvester Supervisor, Industrial Engineering	General Dynamics Land Systems Division Warren, Michigan
Mr. Stan Perkes Engineer, Force Modernization	Tooele Army Depot Tooele, Utah
Mr. Lyman Thorpe Engineer, Force Modernization	Tooele Army Depot Tooele, Utah
Mr. Ben Williams Chief, Force Modernization	Tooele Army Depot Tooele, Utah
Mr. John Maddocks Supervisor, Vehicle and Power Generation Shops	Tooele Army Depot Tooele, Utah
Mr. Joedy B. Schlotzhauer Chief, Manufacturing Engineering Technology Section	Sacramento Army Depot Sacramento, California
Mr. Alfred Hollander Division Chief, Production Engineering Division	Sacramento Army Depot Sacramento, California
Mr. Michael Trowse Supervisor, Industrial Productivity Management	Anniston Army Depot Anniston, Alabama
Mr. Bill Austil Chief Engineer	Mississippi Army Plant Picayune, Mississippi
Captain Ronald Flom Chief Production Support Section	Lima Tank Plant Lima, Ohio
Mr. Kip Hill Tool Engineering Supervisor	Lima Tank Plant General Dynamics Lima, Ohio
Mr. Joseph Lestage Division Chief Engineer	Iowa AAP Middletown, Iowa
Mr. Dean Lichtenberger Sectional Chief Engineer	Iowa AAP Middletown, Iowa

Name/Title	Organization/Location
Mr. Stan Armstrong Engineering Division Manager	Crane AAA Crane, Indiana
Mr. Bill Gates Industrial Engineer	Crane AAA Crane, Indiana

APPENDIX 4

Selected Sources of Information on GT

(4 Pages)

SELECTED SOURCES OF INFORMATION ON GT

BOOKS, MONOGRAPHS AND COLLECTED ARTICLES WHICH PROVIDE AN OVERVIEW OF GT

Burbidge, J. (Editor); Group Technology: Proceedings of an International Seminar. Turin, Italy: International Center for Advanced Technical and Vocational Training, 1969.

Burbidge, J.; Group Technology. London: Heinemann, 1975.

Hyer, N. (Editor); Group Technology at Work. Dearborn, Michigan: Society of Manufacturing Engineers, 1984.

Proceedings of a CAM-I Coding and Classification Workshop. Arlington, Texas: Computer Aided Manufacturing - International, 1975.

Ranson, G.; Group Technology. London: McGraw-Hill, 1972.

Group Technology - An Overview and Bibliography. Machinability Data Center, Metcut Research Associates, Inc., Cincinnati, Ohio.

PERIODICALS PROVIDING GT INFORMATION

American Machinist
Assembly Engineering
CAD/CAM Technology
Computers and Industrial Engineering
Harvard Business Review
Industrial Engineering
Journal of Operations Management
Manufacturing Engineering
Modern Machine Shop
Production and Inventory Management
P & IM Review and APICS News

ASSOCIATIONS WHICH PROVIDE SELECTED PAPERS RELATED TO GROUP TECHNOLOGY

Society of Manufacturing Engineers
Technical Publications
One SME Drive, P.O. Box 930
Dearborn, Michigan 48128

Institute of Industrial Engineers, Inc.
25 Technology Park/Atlanta
Norcross, Georgia 30092

Numerical Control Society
1800 Pickwick Avenue
Glenview, Illinois 60025

CAM-I, Inc.
611 Ryan Plaza Drive, Suite 1107
Arlington, Texas 76011

TREATMENTS OF PARTICULAR FACETS OF GT
(topic is noted in brackets following entry)

Astrop, A.; "Group technology as a way of life," Machinery and Production Engineering, 1975, (January), pp. 42-45. [behavioral aspects of GT]

Grayson, T.; "GT reduces jig and fixture costs," Metalworking Production, 1979, (April), pp. 35-36. [GT principles applied to tooling]

Haveli, G.; "Group technology - classification and coding," American Machinist, 1978, 122 (August), pp. 158-162. [coding and classification]

Heglund, D.; "The many faces of CAD/CAM," Production Engineering, 1979, 26(6), pp. 56-69. [GT and CAD/CAM]

Hyer, N. and Huber, V.; "The human impact of cellular manufacturing," Journal of Operations Management, (forthcoming). [behavioral aspects of cellular manufacturing]

Hyer, N. and Wemmerlöv, U.; "MRP/GT: A framework for production planning and control of cellular manufacturing," Decision Sciences, 1982, 13(4), pp. 681-701. [production planning and control]

Jackson, D.; Cell System of Production. London: Business Books, 1980. [cellular manufacturing]

Knight, W.; "The economic benefits of group technology," The Production Engineer, 1974, (May), pp. 145-151. [potential benefits from GT]

Law, T.; "Group technology/casting classification," The British Foundryman, 1978, 71(1), pp. 1-8. [GT for the foundry industry]

Pullen, R.; "A survey of cellular manufacturing cells," The Production Engineer, 1976, 55(9), pp. 451-454. [cellular manufacturing]

Schaffer, G.; "Group technology via automated process planning," American Machinist, 1980, 124 (May), pp. 119-122. [GT in process planning]

CASE STUDIES OF VARIOUS GT APPLICATIONS
(area of application is noted in brackets following entry)

Beeby, W. and Thompson, A.; "a broader view of group technology," Computers and Industrial Engineering, 1979, 3 (4), pp. 289-312. [multiple uses of coded data base in design and manufacturing]

"Finding the needle - Key to group technology," Production, 1975, 76 (November), pp. 85-87. [coding for design applications]

Gettelman, K.; "Organize production for parts - Not processes," Modern Machine Shop, 1971, (November), pp. 50-61. [cellular manufacturing]

Holtz, R.; "GT and CAPP cut work-in-process time," Assembly Engineering, 1978, (June), pp. 24-27. [computerized process planning and GT]

Huber, R.; "Transfer line hosts family of parts," Production, 1975, (April), pp. 70-72. [manufacturing]

Schaffer, G.; "Group technology expands capacity," American Machinist, 1980, (January), pp. 130-134. [process planning with GT and cellular manufacturing]

Tuttle, H.; "Parts grouping pays handsomely," Production, 1974, (May), pp. 99-105. [variety of manufacturing applications]

Tuttle, H.; "Call it GT or Yankee savvy--Families of parts brings savings," Production, 1974, (November), pp. 88-91. [cellular manufacturing]

COMPANIES WHERE IT IS REPORTED THAT
GROUP TECHNOLOGY IS IN VARIOUS STAGES
OF INVESTIGATION AND/OR IMPLEMENTATION

Aro Corporation, Bryan, OH
Boeing Company, Seattle, WA
Caterpillar Tractor Co., York, PA
Cincinnati Milacron, Inc., Cincinnati, OH
Deere & Company, Moline, IL
Ford Motor Company, Dearborn, MI
General Dynamics, Ponoma, CA
General Electric, Cleveland, OH
General Motors Corp., Warren, MI

IBM Corporation, Armonk, NY
Lawrence Livermore Labs, San Francisco, CA
Lockheed-Georgia Co., Marietta, GA
Otis Engineering, Dallas, TX
Owatonna Tool Company, Owantonna, MN
Pitney Bowes, Inc., Stamford, CT
Sundstrand Corporation, LaSalle, IL
Universal Engineering, Frankenmuth, MI
United Technologies, Inc., Windsor Locks, CT
Union Carbide, Nuclear Division, Oak Ridge, TN
Vickers, Inc. (formerly Sperry-Vickers), Omaha, NB
Westinghouse Electric Corporation, Lester, PA

APPENDIX 5

Report Distribution

(8 Pages)

REPORT DISTRIBUTION

MAJOR SUBORDINATE COMMANDS:

Commander
U.S. Army Armament
Munitions & Chemical Command
Attn: AMSMC-CG (R)
Rock Island, Illinois 61299

Commander
U.S. Army Armament
Munitions & Chemical Command
Attn: AMSMC-CG (D)
Dover, New Jersey 07801

Mr. Nathaniel Scott, Jr.
Industrial Engineer
U.S. Army-ARDC
Bldg. 1
SCF-D(D)
Dover, New Jersey 07801-5001

Commander
U.S. Army Aviation Systems Command
Attn: AMSAV-CG
4300 Goodfellow Boulevard
St. Louis, Missouri 63120

Commander
U.S. Army Communications Electronics Command
Attn: AMSEL-CG
Ft. Monmouth, New Jersey 07703

Commander
U.S. Army Depot System Command
Attn: AMSDS-CG
Chambersburg, Pennsylvania 17201

Commander
U.S. Army Electronics R & D Command
Attn: AMDEL-CG
2800 Powder Mill Road
Adelphi, Maryland 20983

Commander
U.S. Army Missile Command
Attn: AMSMI-CG
Redstone Arsenal, Alabama 35898

Commander
U.S. Army Tank-Automotive Command
Attn: AMSTA-CG
Warren, Michigan 48090

Commander
U.S. Army Test & Evaluation Command
Attn: AMSTE
Aberdeen Proving Ground, Maryland 21005

Commander
U.S. Army Troop Support Command
Attn: AMSTR-CO
4300 Goodfellow Boulevard
St. Louis, Missouri 63120

ARMY AMMUNITION PLANTS:

Commander
Crane AAA
Attn: SMCCN-CO
Crane, Indiana 47522

Mr. Bill Gates
Industrial Engineer
Crane Army Ammunition Activity
Attn: SMCCN-EDP
Crane, Indiana 47522

Commander
Hawthorne AAP
Attn: SMCHW-CO
Hawthorne, Nevada 89415

Commander
Iowa AAP
Attn: SMCIO-CO
Middletown, Iowa 52638

Mr. Joseph C. Lestage
Division Engineer
Army Operations Division
Mason & Hauger-Silas Mason Co., Inc.
P. O. Box 561
Burlington, Iowa 52601

Commander
Kansas AAP
Attn: SMCKA-CO
Parsons, Kansas 67357

Commander
Lake City AAP
Attn: SMCLC-CO
Independence, Missouri 64050

Commander
Lone Star AAP
Attn: SMCLS-CO
Texarkana, Texas 75501

Commander
Longhorn AAP
Attn: SMCLO-CO
Marshall, Texas 75670

Commander
Louisiana AAP
Attn: SMCLA-CO
Shreveport, Louisiana 71130

Commander
McAlester AAP
Attn: SMCMC-CO
McAlester, Oklahoma 74501

Commander
Milan AAP
Attn: SMCMI-CO
Milan, Tennessee 38358

Commander
Mississippi AAP
Attn: SMCMS-CO
Picayune, Mississippi 39466

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DEPOTS

Commander
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Ms. Dawna Mayorga
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Commander
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Attn: SDSLE-CO
Chambersburg, Pennsylvania 17201

Commander
Mainz Army Depot
Attn: SDSMZ-CO
APO New York, New York 09185

Commander
New Cumberland Army Depot
Attn: SDSNC-CO
New Cumberland, Pennsylvania 17070

Commander
Pueblo Army Depot Activity
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Commander
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Seneca Army Depot
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Commander
Sharpe Army Depot
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Lathrop, California 95331

Commander
Sierra Army Depot
Attn: SDSSI-CO
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Commander
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Commander
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Mr. Stan Perkes
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Commander
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LABORATORIES

Commander
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Major Walter W. Olson
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Commander
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Capt. Ronald C. Flom
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Commander
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OTHER GOVERNMENT ACTIVITIES:

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Commander
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Commander
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